SCIENCE

New Series
Vol. LXVI, No. 1716

Friday, November 18, 1927

Annual Subscription, $6.00
Single Copies, 15 Cts.

SCIENCE

VOL. LXVI NOVEMBER 18, 1927 No. 1716

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.

OBJECTIVE AND HUMAN PHYSICS

THE twofold view of nature is as old as theoretical physics. The picture in which nature presents itself to the observer is complicated; but Democritus, the great Greek thinker, had already recognized that this complication is only apparent, and the result of the peculiarities and limitations of the human senses. It was the idea of Democritus that the picture of nature to which true thinking leads must be of much greater simplicity than that which man receives through his senses. The necessary condition for the simplification of physics had therefore to consist in the liberation of physics from all human, from all subjective, points of view.

Democritus also recognized that the objects of the simplest physical events must be much smaller than any object amenable to sense-perception. The exploration of hidden atomic events thus became the essential aim of objective physics.

As soon as the true size of atoms was evaluated by exact methods, the primarily speculative hypothesis became exact scientific knowledge. To-day we can determine the mass of atoms with comparatively greater accuracy than the mass of the earth. Not only through one but through the most varied and independent methods the characteristic constants of atoms can be determined in the most accurate manner; and all these methods, independently of each other, have led to the same values. If it can be regarded as an argument for the existence of our external world that the sensations of sight, hearing and touch all lead us to infer the existence of the same objects, then theoretical physics has certain proof of the real existence of atoms in the fact that their characteristic constants, as obtained by fundamentally different methods, have nevertheless always the same values.

Modern physics, based on the exploration of atomic processes, has revealed to us a picture of nature of great simplicity. It has clearly shown that it is not nature that is complicated, but only the path leading to a knowledge of it, and that this path consists in the gradual transformation of the subjective world-picture into an objective one.

But if the objective picture be the true one, then it should also be possible inversely to construct the subjective human picture from the objective one. We can then raise the question of how, under given powers and limitations of the human senses, nature may reappear in a picture produced by these senses. We

can ask how, from such a subjective picture of nature, a physical science can originate and how, out of the objective qualities of nature, the real development of physics, created by man, is to be understood. I shall discuss briefly these questions.

First, let us ask how nature, of which man receives a certain picture through his senses, may be constituted in reality; how it would appear to a spirit, say to an imaginary demon whose perceptive faculty admitted of no restrictions whatever and who could compare sizes and compare times, but for whom words like "large" and "small," "quick" and "slow" would have no meaning at all.

To such a spirit, matter would reveal itself in countless primordial particles of only twofold sorts. Could he isolate some of them and examine their mutual influence, he would find out that primordial particles of the same sort repel each other, whereas those of opposite kinds attract each other. If he were to construct the fundamental mechanical conceptions, such as force and mass, in the same way as is done by man, he would recognize that the particles of one sort have a mass about 1,850 times greater than the particles of the other sort. He might distinguish the particles of greater mass as positive protons from the other sort which he might call negative electrons.

The spirit would perceive aggregates in which positive and negative primordial particles are comparatively close together, but where the positive particles always have a majority. He might call these aggregates nuclei. Furthermore the spirit would find how negative electrons revolve round these nuclei like planets round a central sun. Such a system formed out of a nucleus and revolving negative electrons might be called an atom by the spirit.

He would find that the orbits in an atom can not be arbitrary ones, but only such that a certain magnitude characterizing the motion in the orbit is exactly a whole number multiple of a definite elementary magnitude. Something like the so-called "harmony of the spheres" would reveal itself in the regularities of the orbits described round the nucleus.

The spirit would also recognize that, as a rule, the number of negative primordial particles contained in an atom is either perfectly or with a small difference equal to the number of positive primordial particles. In the first case (the case of perfect equality) it might speak of a neutral, in the second case (the case of imperfect equality) of a charged atom. Among the various species of atoms perceived by the spirit, one type would strike him by its particular simplicity, namely, those atoms in which only a *single* negative primordial particle runs around a single positive primordial particle which represents the nucleus.

The spirit would also find that out of atoms of a single or of several kinds complexes are formed by mutual attraction which often contain two or more atoms. In this case he might call the said complexes molecules. In some cases he would find single atoms which might be called monatomic molecules.

The spirit would recognize as the most frequent state of matter a state in which the molecules are wildly shooting in all directions, causing perpetual collisions between them. Such a state of matter might be designated by him as gaseous. On the other hand, he might speak of a *solid* state if the atoms are arranged in a definite manner so that the internal motion of matter consists in oscillations. Between the two extremes of the gaseous and the solid state intermediate stages will be perceptible.

Moreover the spirit would find that only a vanishingly small fraction of space is really filled with matter; but that, on the other hand, matter is concentrated in formations which contain, at least in order of magnitude, the *same* number of primordial particles, a number between 10^{55} and 10^{59}. Such formations, rising and disappearing, might be called stars by the spirit. He would find that in the stars the internal motion and also the force of collisions are so tremendously violent that any durable formation of molecules and probably also of complete atoms is prevented.

Around the stars the spirit would recognize formations like our earth which consist of a thousandth or a millionth as many primordial particles and in which the motion gradually being retarded is relatively much slower than in the central stars. When, for instance, the spirit considers the processes on earth, he would find that the internal motion is relatively so slow that both the most solidly constructed nuclei and the atoms and, as a rule, even the molecules wholly withstand collisions.

If the spirit considered any position in space for a given instant, he could determine the magnitude and the direction of the force which would be exerted upon a primordial particle should it be there. This force, measured by any scale, might be called the electric field-strength existing at the given position at the given instant. The spirit would find out moreover that the strength of the electric field can vary periodically in its magnitude and direction, as well as in space, namely, from position to position, and in time from instant to instant. If there exists such a double space-time-periodicity, the spirit might speak of electric waves.

He would find space filled with such waves of very different lengths and of very different frequencies. If a wave has a frequency two, four, eight or sixteen

times as great as another, the spirit might say that its oscillations lie one, two, three or four octaves higher.

The spirit would also recognize that there exists a close correlation between the electric waves and alterations in the structure of matter. Besides the normal states of atoms and molecules there are possible, as the spirit would find out, also abnormal states in which the grouping of the electrons round the nucleus differs from the usual. Such alterations of configuration either require a supply of energy, or energy becomes available through the alteration. The spirit would perceive that the energy liberated can be transformed into energy of an emitted electric wave. Conversely he would find that the energy supplied can spring from an absorbed wave. But he would recognize that in both cases the frequency of the wave can be considered as an immediate measure for the resulting transformation. This rule might be called by the spirit the frequency-condition.

As the simplest atom, we have previously considered one in which a single negative primordial particle revolves round a single positive primordial particle. If this simplest atom passes from its normal state to an abnormal one, which differs the least from the normal, this transition would appear to the spirit as the simplest among all possible alterations of configuration occurring in the atoms. The frequency corresponding to this simplest transition might be considered by the spirit as a standard frequency. Frequencies which extend to about twelve octaves lower or to about fourteen octaves higher than this standard-frequency are produced by alterations in other atoms or in molecules.

Apart from the attraction and repulsion between the primordial particles, the spirit would find a universal attraction of matter. This attraction which he would recognize to be proportional to the product of masses might be designated by him as gravitation. He would notice that gravitation is vanishingly small when compared with those electrical forces already mentioned. If he considered, for instance, two positive primordial particles and if he calculated the ratio between their mutual force of repulsion and their gravitational force, he would find it to be about 10^{36}.

Gravitation, therefore, can act its part only between enormous accumulations of primordial particles, for gravitational effects of the particles are always added, whereas the electrical effects originating from the primordial particles compensate each other by reason of the *neutrality* of matter.

Only in exceptional cases can electrical forces rising from large bodies become so strong as to be able to move other bodies, which are also composed of countless primordial particles, provided the neutrality be removed in a sufficiently large part of the molecules or atoms. Similar results are produced by certain forces which are exerted upon each other by two revolving electrons on account of their revolutions, and which the spirit might designate as magnetic forces. These forces generally compensate each other, but in some substances the compensation can be so imperfect that the magnetic effect may be revealed by comparatively strong forces between bodies containing countless atoms.

Thus far, I have tried to sketch the objective picture of nature as it would appear to a spirit. From the same nature man receives a subjective picture by means of his senses. To all things he first applies a human standard. His body consists of an enormous number of atoms, about 10^{28}, each of which represents in itself a planetary system. Thus it is not astonishing that man considers as exceedingly small such objects as present themselves to the spirit as complexes of many millions of atoms. The shortest movements executed by the human body appear tremendously long from the standpoint of atomic processes. In the time which man needs even to lift an eyelid, each of the electrons in each of his atoms performs millions and millions of revolutions. In a similar way the electric waves filling space perform millions and millions of oscillations during the lifting of an eyelid.

On the other hand, the duration of man's life appears vanishingly short as compared with some physical processes recognized by our spirit, for whom such words as "long" and "short" do not exist. Much that may appear to the spirit in impetuous evolution, like the stars, may afford to man the deceptive impression of duration and immutability.

As the most important human sense-organ, the spirit would recognize one which reacts upon electric waves belonging to a very narrow region. This region comprises but a single octave and reaches from about three to about two octaves below the standard-frequency I mentioned before. The spirit, however, would find that this human sense-organ which he might call the eye is not sensitive to the electric waves which lie beyond those narrow limits.

The spirit would find in man also a sense-organ through which man can recognize whether the internal motion of matter with which he is in contact is more intensive or less intensive than the internal motion of the matter forming the human body, which motion is nearly constant in its intensity. This human sense might be called the sense of temperature.

By means of his eyes man obviously can perceive or, as we might say, he can see such objects which either emit electric waves or which absorb waves of definite frequencies from the totality of electric waves

filling the space, provided (and this is very essential) that the frequencies emitted or absorbed belong to the range of that octave for which human eyes are sensitive. If for such objects the visual angle is not too small, man can perceive them and recognize their size and shape by their boundaries.

On the earth where man lives, matter possesses an internal motion which is relatively so slow that he is surrounded by durable nuclei, atoms and, as a rule, also molecules. Those molecules and atoms which absorb any frequencies belonging to the octave perceptible to the human eye give rise to colored impressions. This happens mostly in the case of solid bodies, but not in the case of the gaseous matter which covers the solid earth as atmosphere and which remains invisible to man owing to the absence of respective absorptions.

Man will differentiate countless substances according to the molecular properties which reveal themselves to him. These substances correspond to the numerous forms in which about twenty frequent varieties of atoms are found combined. Occasionally man perceives the result of a process which would present itself to the spirit as a formation of new molecules caused by the decomposition of other molecules of two or more sorts. Such rearrangements must appear to man, who distinguishes substances according to their molecular properties, as transformations of substances.

On the other hand, the forces acting between the atoms of one and the same substance must also undergo a loosening with increasing intensity of the internal motion. This will become manifest to man by finding that the state of matter depends upon temperature. He will find that bodies which usually have a solid form lose it with increasing temperature and even evaporate under a still higher temperature.

Apart from the bodies found on earth, the stars distributed in the space of the universe will be the object of human perception. Their distances, of course, can not be estimated by an untrained observer. He will put them all into the same indefinite distance. In this way the aspect of a sphere is produced which appears to be covered with stars and might be called by man the firmament.

The velocities of the stars are exceedingly great as compared with terrestrial velocities. Nevertheless, owing to the enormous distances involved, perceptible changes in the apparent configuration of the firmament are not, as a rule, possible during the lifetime of a man. The only exceptions are made by such objects in the firmament as belong, like the earth, to the sun and which might be called by man planets. The changes of their positions in the firmament caused by their proximity must soon awaken the interest of the observer; and in a still higher degree this must be the case with the moon, the companion of the earth.

Thus from the very outset several fields of phenomena become apparent to the careful observer which might be made the objects of scientific research. He first finds plenty of work in two fields in which he can develop an activity, which might be called "cataloguing"—on the one hand by the description of the firmament, on the other hand by the description of the substances amenable to sense-perception and of their properties and changes. Two branches of science which might be called astronomy and chemistry must thus first result from the consideration of the subjective world-picture.

Furthermore, man observes changes of position or motions both on the earth and in the firmament, without at first recognizing a connection between terrestrial and celestial motions. In the case of terrestrial motions he again distinguishes two kinds: on the one hand, so to speak, the forced motions which he produces himself either immediately by means of his arms or indirectly by means of mechanical contrivances invented by him; on the other hand, there are the natural, or ordinary motions which are caused by the gravitational field of the earth and which are chiefly revealed to man in the phenomenon of falling.

Now and then man may also discover motions which are caused by electrical or magnetic forces. These will occur when matter appreciably differs from neutrality or from complete compensation of the electron orbits. These anomalies are, of course, due to special molecular or atomic properties. Therefore, man will ascribe the faculty of putting other bodies into motion, only to substances that appear unique to him.

Another object of the study of nature may be the process of vision itself. The untrained observer of nature can not have any idea what the physical process may be which occurs in the space between the eye and the object perceived. As his conception of nature is thoroughly subjective, he will even assume this process to originate in and from his eye.

But, in any case, it becomes evident that electric waves in the objective sense of this word change the direction of their propagation if they strike upon bodies or pass through them. For under certain circumstances man sees objects in other than their real positions. He discovers a reflection—by closer observation occasionally also a refraction—of the rays which he assumes cause vision. In any case, many problems result from the spatial relations of the three positions: where the eye is, where the object is in reality, and where the object seems to be.

Finally, the sense of temperature must also open up to man a peculiar field of phenomena in which he can make various observations. On the one hand he

perceives continuous fluctuations of temperature in nature. On the other hand, he learns artificially to vary the temperature. The changes which are produced in the structure of bodies by changes of temperature may also become subjects of research; and above all man must be interested from the beginning in the processes thus taking place in the atmosphere.

Thus, in the first period, human physics, based on the subjective world-picture, chiefly consists in the recording of the phenomena which nature spontaneously offers to the observer. During this earliest period of physics—I should almost like to say during its prehistoric period—man first recorded the stars perceived by him. According to the accidental apparent proximity in the firmament, which proximity in itself has nothing to do with the real arrangement in space, he classifies the stars in groups or so-called constellations. He pursues the apparent course of sun and moon and the apparent orbits of the planets in the firmament. He recognizes those properties of the various substances found on earth which are amenable to his sense-perception. He pursues the course of the rays which he assumes cause vision. He observes, although at first in a rather superficial manner, the natural and the forced motions; and for practical reasons he occupies himself with the question of how, if he makes use of mechanical contrivances, he can bring about the desired effect with the least expenditure of force. And this question must lead him up to the investigation of the equilibrium of simple machines.

Among these various fields of phenomena, there are two in which numerous physical theorems may be gained from relatively few empirical conceptions, by means of deductive mathematical methods. On the one hand, the comprehension of a single simple case of equilibrium is sufficient for the solution of rather difficult problems of equilibrium by means of geometrical knowledge. On the other hand, the geometrical method also renders possible a study of the complicated problems of reflection of rays, provided a single, simple physical law be discovered in this branch of science.

Thus the earliest phase, the cataloguing phase, of physics is followed by a period in which physics begins its development into an exact science. During this period it still shows a purely mathematical character. The great achievements of the Greeks in statics and catoptrics are characteristic of this early period. Chemistry and the study of heat, on the other hand, remain in their rudimentary phase. In astronomy the study of stars advances, and a geometrical theory, becoming more and more complicated, tries, with increasing accuracy, to describe the apparent orbits of planets.

Thus exact physics in its beginning is but a branch of applied mathematics. But by and by, through the work of physicists, the small amount of existing empirical material will be enlarged. The result of this work must greatly accelerate progress in physics, for new physical knowledge brings about new methods of research.

While in the first period physics remained restricted to passive observation of spontaneously occurring events, now the processes to be investigated are artificially produced by systematic experiments. Thus man becomes not only able to vary at will the essential attendant circumstances and the degree of the processes, but events which must remain hidden to the passively observing individual become amenable to his natural or to his refined instrumental perception. The inductive method is finally combined with the deductive one. The investigator derives from the established facts by mathematical deduction new conceptions which he then verifies by new experiments.

In the period of physics which follows the purely mathematical one, mechanics and optics are chiefly developed. Exact dynamics originates from the investigation of the simplest motions caused by forces, such as from falling. The exploration of this phenomenon delivers the key for the discovery of the fundamental laws of motion. The exploration of the mechanical properties of air which are hidden from immediate sense-perception shows how human perceptive faculty has already grown beyond the limits drawn for human sense-organs.

In optics the study of refraction causes the invention of means which artificially raise the faculty of the human eye to a high degree. Instruments thus invented not only produce previously unsuspected discoveries in various fields of natural science, but also allow a much closer observation of the optical phenomena themselves. Thus gradually the knowledge arises that light constitutes a wave-like process.

The science of heat developed much more slowly than that of mechanics and optics. Because here the establishment of magnitudes which might be exactly measured is much more difficult than in mechanics and optics where all quantitative relations are based upon lengths, angles and times.

In chemistry experimental researches lead to the finding of numerous, previously unknown substantial transformations. Their closer investigation leads to the gradual discovery of the chemical elements which correspond to the varieties of atoms and which reveal themselves as the undecomposable constituents of chemical compounds.

The advancing perfection of experimental methods must finally place in the foreground those phenomena

which are the most original and important from the objective point of view, but which play the most subordinate part in the primitive subjective world-picture, namely, electric and magnetic phenomena. That these phenomena may become perceptible, matter must, as I have already mentioned, deviate from its usual neutrality. The physicist gradually contrives means artificially to raise these divergences. Thus he can explore phenomena which the untrained observer perceives only in a weak, occasional and exceptional way. In studying bodies which are built up of countless atoms, he gradually discovers those electric and magnetic laws which are valid in the atoms themselves.

The detailed investigation of phenomena in the various branches of physics must necessarily render physics more and more objective. Such a liberation from subjective human points of view is first to be expected in astronomy. An ingenious thinker discovered that the most complicated planetary motions appear very simple if astronomy gives up her subjective geocentric point of view. In the same way, a great physicist arrived at the discovery that the motions of planets and their satellites represent the same phenomenon as the motions of falling, daily perceived by man on earth.

The identity existing between the internal motion of matter and visible motions must likewise reveal itself to the physicist. It becomes manifest by the fact that in the production of heat by mechanical work as well as in the converse process a constant ratio is found to exist between the quantities of heat and mechanical energy mutually converted. Thus the theoretical physicist is led to recognize that the phenomena of heat consist only in invisible and hidden motions. He also finds how by this assumption many perceptible properties of gases can be simply explained.

That physics becomes more and more objective also becomes manifest in the investigation of electric waves (in the objective sense of this word). In the investigation of these waves man advances more and more beyond the boundaries which at first are drawn by the limitations of vision. Already the untrained observer perceives not only those electric waves of a single octave which appear to his eye as light, but also electric waves of a much greater wave-length which he feels as heat-rays through his temperature sense. The identity of light and heat-rays must become manifest to advancing science. On the other hand, chemical effects discovered with usual light render possible an investigation of waves shorter than those of visible light. Thus physics advances in both directions beyond the limits of the visible spectrum.

Finally the physicist becomes able to produce oscillations and waves by contrivances used by him in the experimental study of electricity, and he finds that these electric waves artificially produced show the same properties as he has long since known of the much shorter waves which he perceives as light. Thus the electric nature of light reveals itself to man. As he found the science of heat to be a branch of mechanics, he now recognizes optics to be a branch of the science of electricity.

The great advances made in all branches of physics must finally open up to the investigator an insight into the world of atoms. The real existence of atoms first reveals itself to man in chemical laws which must be interpreted by the assumption that the smallest particles of chemical compounds are built up of atoms of elements. Still more clearly the atomic structure and electric nature of matter manifest themselves in such chemical changes as are due to electric currents. Finally a system of elements can be established, and in it such similarities between chemical elements appear which, in reality, are caused by similar arrangements of electrons in atoms.

In the science of heat the hypothesis of hidden motions in itself leads to a molecular conception of matter. And the deeper understanding of the laws discovered in thermodynamics makes them appear as results of molecular statistics.

In the science of electricity, the perfection of experimental methods must lead to the finding of processes in which electrons or parts of atoms constitute a perceptible radiation; and thus their closer investigation leads to the discovery of the primordial particles themselves. On the other hand, greatly refined methods of observation make it possible to perceive the consequences of rather rare events, that is occasional disintegrations of nuclei. Also from these phenomena, known as phenomena of radio-activity, important conclusions can be drawn in regard to the building stones of matter.

The most valuable empirical material for the investigation of atoms is, however, offered by the phenomena of the line-spectra. By means of the frequency-condition previously mentioned, theoretical physicists learn to understand the language of the spectra which reveal to man the internal structure of atoms.

Thus physics has arrived at its present state and at its present knowledge which I took the liberty of symbolizing in the spirit. To believe that physics has already reached perfection would, of course, be a dangerous illusion. But perhaps the physicists of to-day may have a similar conception of the state of physics as geographers may have of the state of their science.

Geographers know that to-day there are no more continents and seas to be discovered. They, however, have no doubt that in their science fundamental problems are unsolved as yet and still may occupy scholars through centuries. The state of physics, the world-picture and evolution of which I have tried to sketch, may perhaps be similar.

ARTHUR HAAS

VIENNA

LOUIS AGASSIZ FUERTES

As already noted in SCIENCE, Louis Agassiz Fuertes was suddenly killed at Unadilla, New York, August 22, when the automobile he was driving was struck by a moving train. In the many printed notices which appeared immediately after his passing, superlatives have been used freely and justifiably. "Foremost American painter of birds," says one; "Cornell's best beloved alumnus," says another; and all testify to the extraordinary personal popularity which he enjoyed.

He was indeed a unique character, the like of which is scarcely produced except in America. He was born at Ithaca on February 7, 1874. His father, Estevan Antonio Fuertes, one time dean of civil engineering at Cornell, was a man of outstanding character and ability. This father, whom Cornell students used to call "The Mogue," was of Spanish lineage, born in Porto Rico, but completing his education in New York. The mother, Mary Stone Perry Fuertes, now surviving at an advanced age, is a fine American type of English, Dutch and Huguenot ancestry. The remarkable combination of qualities developed by Louis Fuertes doubtless owed much to this parentage.

His especial professional godfathers were Abbott Thayer and Elliott Coues with whom he had close association for which he never ceased to make loyal acknowledgment. As a boy, his passion for the beautiful in nature had fairly free rein and his early drawings of birds were made practically without suggestion or guidance from others. However, neither he nor his parents thought seriously of ornithology or painting in any practical way, and his father expected him to enter the engineering or architectural profession. This idea was overcome to some extent through the influence of Liberty H. Bailey, and shortly before Louis graduated from Cornell in 1897 a fortunate coincidence led him to send a few samples of his bird paintings to Elliott Coues for criticism. The enthusiastic reply received from the great ornithologist was fulsome beyond his hopes. He was electrified with joy, and from that moment was never in doubt as to his purpose in life. Coues literally took him under his wing, hailed him as a new and better Audubon, and introduced him to the ornithological world in such a way that contracts to illustrate several books were soon in his hands.

He began at once to portray bird life in a way that appealed alike to the artist and to the ornithologist. At this time the long era of woodcuts and expensive lithographs was just passing. General interest in outdoor life and especially in birds in this country was awakening and the demand for good books of nature was growing. To say that Fuertes arrived opportunely to take advantage of the period does him injustice, for his influence was very powerful in stimulating and supporting the movement and but for him it would have been delayed or curtailed. Other artists and good ones came into the field, but it was Fuertes who set the standard, who inspired the ideal of all, and by abundant production spread broadcast the charm and beauty of birds, not merely in accuracy of line and color, but in the expression of subtle intangible qualities approaching spirituality. In effect the word went about that birds had souls and that Fuertes could see and transcribe them.

For thirty years his activity and industry were phenomenal. He illustrated book after book, sometimes with only a frontispiece or a few plates, but usually with a whole series covering all the species known from a wide area. A large percentage of the more important bird books published in America during this period contain pictures by Fuertes. One of the most important was the series of large plates in full color for Eaton's "Birds of New York" (1910), covering practically every species of eastern North America. At the time of his death he was under contract with the State of Massachusetts for a similar and even better set of plates, one volume of which had been finished and issued. He also furnished plates for various ornithological journals, for museum publications, for the National Geographic and other magazines, and for the widely distributed pamphlets and reports of the federal government. In all this, he was often under pressure, but his standard was high and the average quality of his production was never far from it. The demand for mere illustrations, however, prevented him from giving his talent the widest range. Had he lived, it was his well-determined intention to finish his contracts, to take no more which savored in the least of pot boiling, and to devote an entire year to untrammeled self-expression or, in his own words, "to paint whatever I want to paint, whether I can sell it or not"—not merely birds, but pictures, pictures with birds in them.

He had, in fact, painted such pictures before, but

his opportunities in this direction had been all too limited. A commission which he thoroughly enjoyed and in which he was signally successful was that of painting a series of twenty-five decorative panels in the private house of Mr. F. F. Brewster, New Haven, Connecticut. He also did some murals in the Flamingo Hotel, of Miami, Florida, and several large paintings for the collection in the Administration Building of the New York Zoological Society. His contributions to the backgrounds of the habitat groups of birds in the American Museum of Natural History were notable. In addition, he painted a certain number of mammals and domestic animals and, while some of these which he did not know in life were lacking in sympathy and below the standard of his pictures of wild birds, there were many of high quality, indicating that he might also have succeeded in this field.

In 1904, he was married to Margaret E. Sumner, of Ithaca, and their home was made "above Cayuga's waters" at the edge of the Cornell campus. There are two children, Sumner and Mary, to whom he was a most devoted father. His studio, which was detached but adjacent to his house in Ithaca, was a Mecca for prominent ornithologists from all parts of the country and a house of wonders to students of Cornell and other young people of the community. In it he kept not only his studies and sketches but an interesting assortment of curios and souvenirs picked up on his travels to various parts of the world. There was also his very choice collection of bird skins which, although it did not exceed 4,000 specimens in number, was especially selected and rounded out to meet the exacting needs of his work. This collection was largely the result of his own field work, birds that fell to his own gun, and were preserved by his own hand.

In his earlier years, Fuertes sometimes said half jestingly that he was an ornithologist first and a painter afterward. His genius as a painter will never be denied, but it is plain that his supremacy in his field was gained by many qualities besides mere skill as a draughtsman and colorist. His knowledge of birds was exceedingly extensive and, in some respects, almost profound. It was obtained mainly through direct contact with the subject. Probably it is not too much to say that Fuertes had a wider acquaintance with living birds in the field than any painter that ever lived. This was because he sought them out, not primarily to paint them but to know them and to enjoy them, often at the sacrifice of time and money. It was characteristic of him to do field work under various auspices. A general favorite himself, he played no favorites and was *persona grata* in all quarters. His first long trip was with the Harriman-Alaska Expedition; later he joined a party from the U. S. Biological Survey for work in Texas and New Mexico; and for several seasons he was associated with his friend, Dr. Frank M. Chapman, in expeditions for the American Museum of Natural History to Canada, Mexico and South America. He also visited California, Florida and the West Indies. His last and longest journey was as ornithologist and artist of Field Museum's recent expedition to Abyssinia, where he personally collected and prepared no less than one thousand birds and made about one hundred paintings and sketches.

The affiliations which he made with different institutions were mutually advantageous and usually so arranged that he retained originals of sketches and paintings for himself while specimens collected were shared, but so conscientious was he that what some might have considered his own interest was often neglected. He was a good shot, an ardent collector, and had such an inexpressible joy in the living bird and its surroundings that he would forget everything else including his painting. His day in the field was so occupied with hunting, observing and preparing specimens that he rarely had time for painting, even though he worked far into the night. Somehow, at odd moments, he made field sketches which in the aggregate were very many, but they were largely for recording the fugitive colors of soft and unfeathered parts which are altered in the preserved specimen. For the rest, he depended upon the genius of his uncanny faculty for retaining vividly impressions of those intimate "spiritual" qualities which gave each bird he painted its own distinctive "personal" character.

In the field, as elsewhere, Fuertes showed an extraordinary combination of qualities, at times almost paradoxical. Always as eager as a child, he was often as sentimental as a debutante and as sympathetic as a mother; yet he was full of a stern virility which continually manifested itself in ways that left no doubt he was a man's man. With gun in hand he was a hunter and collector, having no qualms at the shedding of blood, but with a freshly killed bird before him he would sometimes sit stroking its feathers in a detached ecstasy, purring and crooning over it in a manner that in another might have seemed ridiculous. On the trail, the sight of a new bird might cause him to abandon in a flash all practical considerations, his own safety or comfort, plans for the day, and hopes for the morrow. Yet that night in camp, it would be Fuertes who spent an hour of his precious time repairing ingeniously and most practically for someone else broken saddle gear, guns, typewriters or cameras. Pure beauty in all things fascinated him, and the exquisite combinations of

color and texture exhibited by many small birds were his constant joy, but it is significant that his favorites among all birds were the falcons, the swiftest, boldest, most dashing and, withal, the most rapacious and inexorably bloodthirsty of their kind.

In Abyssinia, Fuertes found himself in a veritable terra incognita, an ornithological world which was all new to him, and he plunged into it with an exuberance of joy. Every bird was an adventure and every moment an opportunity. Patience he had at the skinning table and the drawing board, but at other times it was not always evident and in his impetuosity he was occasionally near to disaster. His first day in Africa was in Djibouti on the coast of the Red Sea and, while others made necessary arrangements for progress inland or sipped cool drinks on the hotel veranda, he slipped out of the settlement, dodging local gendarmes, and in the sweltering heat collected seventeen birds which were skinned with penknives that night in the hotel. The next day on the train, after it had crossed the Abyssinian border but before customs regulations had been complied with, he was tantalized by unknown birds seen at a distance. Finally, at a small station, over the heads of a gaping and jabbering crowd of Abyssinians, a beautiful blue roller alighted on the telephone wire and Fuertes could stand it no longer, but dove into his luggage for a small shot pistol and started out of the standing train intent on having the bird in his hands, come what might. It required the combined efforts of the four other members of the party with argument and at least with threatened force to convince him that the bird was not worth the almost inevitable altercation with bystanders which would follow. Arrived in the capitol at Addis Ababa, Fuertes was subjected to a staggering blow. While all other equipment shipped by freight had arrived safely, his own personal outfit had suffered the mischance of being lost in transit without hope of recovery for three months. It contained his shotgun, his clothing and personal effects and, most important of all, his materials for painting and sketching. His disappointment was too keen to be wholly concealed, but when he was finally told the worst, he said at once, "Well, it simply means I'll have more time to collect birds for the Museum." His other expressed regret was that certain little knicknacks and home-made conveniences for camp life, which he had packed in sets, could not be shared with others of the party as he had intended. Nothing could be more characteristic of him than thus to see his own misfortune in the light of its relations to others.

His unselfishness in all human contacts was marked and perhaps it was but a slightly different form of this that made him so unsparing of himself in his work. He did not often look for the easiest way and would tear through brush and thickets, plunge into morasses, and fearlessly descend steep cliffs to attain his object. In the first few days in Abyssinia, an impetuous sally left him with a large thorn deeply imbedded and broken off in his leg. It could not be removed without a deep incision, so it was thought best to leave it alone. The next day the wound was inflamed and sore, but he would not listen to postponing the march. He was lifted into the saddle and remained there doggedly suffering during what proved to be for everybody the longest and most gruelling day of the whole trip. Thereafter, for nearly two weeks, he mounted and dismounted in agony, but this did not prevent him from doing it many times a day in order to collect birds along the trail which might not be obtained later. Probably no picture in the many of a very eventful trip will remain longer with the others of the party than that of Fuertes laboriously easing himself from his mount to the ground and painfully hobbling away with cocked gun, alert and determined that no needed bird should escape because of any leniency to himself.

His fondness for children, so well known at home, and his tender, almost feminine sympathy for the ailing and unfortunate, were much in evidence in Africa. Beggars and cripples were a great trial to him and it was exceedingly difficult for him to pass one by. He gave to many and almost immediately would apologize to his companions, saying "I know I shouldn't do it, but I just can't help it." If he found one imposing upon him, however, his pity turned to wrath instantly. One of the caravan men, a "nigger" if one wished, developed a loathsome abscess in the groin, and Fuertes carefully washed, poulticed, and bandaged it day after day until it was completely healed. Then the man, who was a worthless wretch, flagrantly betrayed his trust as guardian of the camp, was summarily discharged, and no one was louder in approval of the action than Fuertes. His sense of justice was marked and he was outspoken in his condemnation of sham and insincerity. This extended into the field of art and science and his great personal popularity was not unbroken by a few enemies who well deserved his forthright denunciation. He had no quarter for self-seeking pseudonaturalists and no sympathy with certain schools of new art which arrogate to themselves an insight transcending that of other mortals. There was nothing mawkish about him.

Fuertes was actively interested in a variety of subjects other than ornithology and painting. These included music, architecture, primitive art, conservation, and all movements concerned with young people. Although his conversation usually sparkled with origi-

nality and his correspondence gave much evidence of literary power, he wrote very little for publication. His most important written work appeared first in *Bird Lore* and, later, in pamphlet form under the title "Impressions of Tropical Bird Voices." It was a charming and valuable contribution to a little known subject. He was much interested in bird songs but had no fanciful ideas about them and especially condemned attempts to relate them with human music except by mere notation. His powers of mimicry were most unusual and he was greatly in demand at gatherings of all kinds, not only for his imitations of birds and other animals, but for various "stunts" for which his sense of humor and his natural histrionic talent qualified him to a remarkable degree. These things contributed to his popularity and when combined with the pure gold of his character and the achievements of his profession served to mark him as a very outstanding man.

In 1925, he was made a lecturer in ornithology at Cornell and, although he took this responsibility seriously, it has been said that he accomplished more by example than by precept. His influence was felt among the citizenry of Ithaca in many other ways, as a Rotarian, as a master of Boy Scouts, as a friend and guide for all young people, with the result that he is mourned not only by the university but by the entire community.

During the few weeks since his death, there have been those who have not hesitated to pronounce him the greatest painter of birds that ever lived. There is much to justify such a large place for him, and time is not likely to modify it greatly. Certain it is that he marks an era for American ornithologists and that in him skill with the palette and pencil was combined with qualities of mind and character to produce a very rare result.

Wilfred H. Osgood

Field Museum of Natural History,
Chicago

SCIENTIFIC EVENTS

GIFTS TO COLUMBIA UNIVERSITY

At the October meeting of the board of trustees of Columbia University gifts were announced totaling $210,000, including the following:

Mrs. Walter B. James, $25,000 to be added to the Walter Belknap James research fellowship fund established by bequest from Dr. James. Laura Spelman Rockefeller Memorial, $20,000 for research in education. Borden Co., $18,000 to establish the Borden research fund in food chemistry. Mrs. Lucius Wilmerding, $14,429.93 to be added to the special tuberculosis fund in the Medical School. J. William Clark, $10,000 for the School of Dental and Oral Surgery building fund; Walker Gordon Laboratories Co., $5,000 for research in food chemistry and nutrition; National Lead Co., Eagle Picher Lead Co., St. Joseph Lead Co., United Metals Selling Co., American Smelting and Refining Co., and U. S. Smelting and Refining Co., $4,842.75 for research work in the department of physiology; Motion Picture Producers and Distributors of America, $4,500 for research in applied psychology; William J. Gies fellowship fund committee, $3,518 to be added to the fellowship fund; Fritzsche Brothers, $3,000 to provide the stipend for the Fritzsche fellowship in the department of chemistry; Hartley Corporation, $2,600 for the Marcellus Hartley laboratory; Copper and Brass Research Association, $2,500 for research in the department of physiology; William Fellowes Morgan, '80, '84S, $2,500 for the Medical School; Mines '17, $2,500 for an Engineering School student loan fund; P & S, '12, $2,472.77 for the benefit of the Medical School; Robert H. Montgomery, S. W. Adler, $1,500 for purposes to be specified by the dean of the Medical School; anonymous, $1,500 for work in public health; E. I. du Pont de Nemours & Co., $750 for a fellowship in industrial chemistry; J. Russell Smith, $500 for a special fund for economic geology; Lehn & Fink, $400 for a research fellowship in organic chemistry; Miss Mary Wheelwright, $350 for research in anthropology; Mrs. Elsie Clews Parsons, $350 for research in anthropology; Gano Dunn, '91 Mines, $350 for the Gano Dunn scholarship in applied science; $300 for research in the field of Indian music; Harvard University, $250 to be added to the William J. Gies Fellowship Fund; Bunker Hill and Sullivan Milling and Concentrating Company, $157.25 for research in the department of physiology; D. H. Burrell & Co., $100 for research in the department of anthropology.

RESEARCH IN MINING AND METALLURGY AT THE CARNEGIE INSTITUTE OF TECHNOLOGY

Fifteen different research studies in mining and metallurgy are being carried on this year at the Carnegie Institute of Technology in cooperation with the United States Bureau of Mines and two advisory boards of mining engineers, metallurgists, steel operators and chemists. Thirteen of the problems are being investigated by college graduates appointed as research fellows, one by a research engineer, and another by an analyst.

This year's work, it is announced, is a continuation of the program that has been in effect for several years. Each research fellow is making his studies under the direction of a "senior investigator" representing the Bureau of Mines and a member of the faculty of the Carnegie Institute of Technology. Four of the fellowships are financed this year by the institute. Other organizations contributing to the expenses and the fellowship funds are the American

Gas Association, New York Edison Company, Philadelphia Storage Battery Company, and 26 companies representing the metallurgical industries. The latter group is financing six of the investigations.

Assignments of problems to the research fellows have been made as follows:

Equilibrium between manganese, iron and sulphur, by Hershall V. Beasley, University of Tennessee.

Synthesis, testing and application of warning agents for manufactured gas, by Harry A. Brown, Lehigh University.

Formation and identification of inclusions, by John M. Byrns, Case School of Applied Science.

Coal ash fusibility as related to clinker formation, by Clarence L. Corban, Rose Polytechnic Institute.

Methods of determining inclusions, by John F. Eckel, University of Kansas.

Distribution of iron oxide between slag and metal, by Hyman Freeman, Georgia School of Technology.

Base exchange in relation to decay and peat formation, by Raymond C. Johnson, Monmouth College.

Safety, costs and efficiency of distribution of electric power in coal mining, by Donald C. Jones, research engineer.

Physical chemistry of steel making, by Frank Morris, analyst.

Relation between composition and oxidizability of coal, by Harold M. Morris, Cornell College.

Viscosity of open-hearth slag, by Frank G. Norris, Purdue University.

Composition of oils and heavy tar from distillation of coal at low temperature, by Robert N. Pollock, University of Washington.

Determination of relative ignitibility of low temperature coke compared with coal, by Donald L. Reed, University of Washington.

Study of cause and control of abnormality in case carburized steel, by Alfred W. Sikes, University of Illinois.

Physical chemistry of steel making (field studies), by R. W. Stewart, Massachusetts Institute of Technology.

FOSSILS OF BAFFIN LAND

Mr. Sharat K. Roy, assistant curator of invertebrate paleontology of the Field Museum and geologist of the Rawson-MacMillan Arctic Expedition, has recently submitted to the director of the museum a report regarding the fossils collected by the expedition during the past season. The area covered included the Labrador Coast and the southern end of Baffin Land. The only fossils found in Labrador were a few drift fossils that had evidently been carried down by ice from the Hudson Strait region and Baffin Land. With the exception of one solitary area north of the Strait of Belle Isle, no sedimentary deposit was found on the entire coast of Labrador. The single area referred to has been fully worked by the Canadian Geological Survey. The only important collecting ground observed was in Frobisher Bay, Baffin Land. This bay, situated on the southeast side of Baffin Land, extends in a general northwesterly direction for about one hundred and fifty miles. The upper part of the bay has many rocky capes, numerous islands and shoals and is divided into two arms. A group of larger islands, containing Chase and Gabriel Islands, occupy the middle of the bay. The southeast coast of the bay (Kingaite side) is composed of high, rugged, barren, igneous hills indented by numerous fiords and partially covered by Grinnell Glacier, which discharges by way of several tongues into the bay. The general dip of the beds was found to be S. 70° E. and N. 70° W. The coast has all the marks common in a glaciated region, such as lakes, cirques, hanging valleys and deep fiords. In the valleys between the hills, lakes formed by the damming of streams by moraines, eskers and kames are not uncommon. The physiography of the southwest coast is essentially the same, except that the hills are not so high and there is no existing glacier. The northeast coast of the bay is also a barren, rugged land, but does not show the work of ice as conspicuously as the other coast. Another contrasting feature of the northeast coast is that the hills are massive and seldom show any bedding planes.

Both coasts of the bay were examined as thoroughly as time permitted and collections of fossils were made at eleven different points. The fossils found on either coast of the bay were all drift fossils of Trenton and Utica stage and were doubtless brought to the coast from the interior of Baffin Land. No sedimentary deposit in place, either fossiliferous or non-fossiliferous, was observed anywhere except at Silliman's Fossil Mountain, where the largest and best collection of fossils *in situ* was made. This mountain is in 63° 43′ N. Latitude and 69° .02′ W. Longitude. It stands at the head of the bay, about 300 feet from high tide and 2½ miles south of the Jordan River. It is a hill of limestone which lies unconformably on the hills of Meta Incognita. It is about three fourths mile long and 320 feet high (by aneroid) and runs in a general northwest and southeast direction.

All the fossils found here were of Middle Ordovician age (Trenton and Utica stage). They included the classes Brachiopoda, Lamellibranchia, Gastropoda, Cephalopoda, Trilobita and other Arthropoda, Echinodermata, Coelenterata and Porifera—the Cephalopoda being the most abundant. About 500 specimens were collected.

The only previous collecting known to have been carried on here was by two parties, one led by Captain C. F. Hall in 1862 and the other including Messrs. Carpenter, Porter, Shaw, White and Goodridge, of the

seventh Peary Arctic Expedition in 1897. Hall's collection was only a handful, consisting of twenty-seven species in all, but he was the first to make known the occurrence of fossils on the southeast side of Baffin Land. His collection is now in the museum of Amherst College. The collection made by the five members of the Peary Expedition was better and larger than Hall's and numbered seventy-two species. Part of this collection is now in the U. S. National Museum and part in the American Museum of Natural History. Dr. Schuchert, of Yale University, described and figured this collection in his publication "On the Trenton Fauna of Baffin Land." The collection made by Mr. Roy contains many species not listed by Schuchert and is believed to be the best and most complete assemblage of Arctic Trenton fossils that has yet been made. From the observations and collections it is concluded that both sides of Hudson Strait, Frobisher Bay, Cumberland Sound and the interior of Baffin Land as far north as Ellesmere Land have but one fauna, namely, the Middle Ordovician fauna of Trenton and Utica stage.

GEOLOGY AT THE NASHVILLE MEETING OF THE AMERICAN ASSOCIATION

Section E of the American Association for the Advancement of Science (geology and geography) will hold its sessions at Nashville on Tuesday and Wednesday, December 27 and 28, in the geological lecture room at Vanderbilt University. The general headquarters for the section will be the Andrew Jackson Hotel, Deadrick Street and 6th Avenue. The stated price of single rooms at this hotel is $2.50 to $5.00.

Tuesday will be devoted to a symposium on the Mesozoic-Cenozoic stratigraphy of the Gulf States. At the morning session from 9:15 to 12:30 the mapable formations will be discussed by state geologists: Florida, by Herman Gunter, of Tallahassee; Georgia, by S. W. McCallie, of Atlanta; Alabama, by W. B. Jones, of Tuscaloosa; Mississippi, by E. N. Lowe, of Jackson; Louisiana, by W. C. Spooner, of Shreveport, and Texas and southeastern Oklahoma, by E. H. Sellards, of Austin. Vice-president Charles Schuchert will present "The Paleogeography of North America during the Triassic and Jurassic." At the afternoon session, 2:00 to 5:30, correlations will be given by paleontologists: L. W. Stephenson, "The Major Marine Transgressions, Regressions and Structural Features"; T. W. Stanton, "The Lower Cretaceous or Comanchean Formations"; L. W. Stephenson, "The Upper Cretaceous or Gulf Series"; C. Wythe Cook, "The Cenozoic Series East of the Mississippi River"; Julia A. Gardner, "The Cenozoic Series West of the Mississippi River on the Basis of the Larger Fossils"; F. B. and H. J. Plummer, "The Midway Correlations on the Basis of the Foraminifera"; E. W. Berry, "Correlations on the Basis of Fossil Plants"; O. P. Hay, "Correlations on the Basis of Fossil Vertebrates." A smoker for Tuesday evening is tentatively planned.

On Wednesday one or two sessions will be held for the reading of general papers. Titles accompanied by abstracts of not more than 250 words should reach the secretary not later than November 29. On Wednesday also the section will join with the Association of American Geographers in a symposium on "Problems of the Mississippi River." On Wednesday evening Section E will combine with the Association of American Geographers in a joint dinner, at which the addresses of the retiring president, M. R. Campbell (A. A. G.) and the retiring vice-president, G. H. Ashley (Section E), will be read.

The railroads are offering reduced rates on the certificate plan and all who attend are urged to secure certificates when purchasing tickets.

G. R. Mansfield,
Secretary, Section E

U. S. Geological Survey,
Washington, D. C.

SCIENTIFIC NOTES AND NEWS

The Nobel prize in physics for 1927 has been divided and awarded by the Swedish Academy of Sciences to Dr. Arthur H. Compton, professor of physics at the University of Chicago, and to Dr. Charles T. R. Wilson, Jacksonian professor of natural philosophy at the University of Cambridge.

The Royal Society has awarded the Hughes medal to Dr. W. D. Coolidge, assistant director of the research laboratories of the General Electric Company; the Davy medal to Dr. Arthur A. Noyes, director of the Gates Chemical Laboratory at the California Institute of Technology, and a Royal medal to Professor J. C. McLennan, director of the physical laboratory at the University of Toronto.

On the occasion of the celebration of the semi-centennial of the University of Colorado, twenty-three honorary degrees were conferred, including the doctorate of laws on Dr. Robert A. Millikan, director of the Norman Bridge Laboratories of the California Institute of Technology; on Dr. Roscoe Pound, dean of the law school of Harvard University, and on Dr. Melville F. Coolbaugh, president of the Colorado School of Mines, and the doctorate of science on Dr. S. C. Lind, director of the school of chemistry of the University of Minnesota, on Dr. Henry Sewall, professor of physiology in the University of Denver, and

on Dr. Milo S. Ketchum, dean of the college of engineering of the University of Illinois.

The medal of the Explorers' Club of New York has been presented to Dr. Fridtjof Nansen, Polar explorer, by Laurits S. Swenson, American minister to Norway, in behalf of the National Geographic Society of America. The presentation was at a dinner at the American Legation in recognition of Nansen's Arctic achievements.

Dr. Knud Rasmussen, the Danish Arctic explorer, had conferred upon him the doctorate of laws by the University of St. Andrews on October 7.

Presentation of the cross of the Legion of Honor, awarded to Dr. Isaac Abt, professor of pediatrics at Northwestern University, by the French government, was made at a special convocation at the medical school on November 4.

Dr. Fred H. Albee was decorated with the order of Commander of the Crown of Roumania at Bucharest on October 27, for his "contributions to the advancement of bone surgery." Dr. Albee delivered a course of lectures in Bucharest on orthopedic surgery.

H. W. Hardinge, president of the Hardinge Company, of York, Pa., has been awarded the Edward Longstreth medal by the Franklin Institute for his invention of a rotary air classifier.

The council of the Institution of Civil Engineers has made the following awards: The Howard quinquennial prize to Professor W. E. Dalby, in recognition of his researches on the strength and structure of iron and steel; the Indian premium to A. W. Stonebridge. For selected engineering papers published during session 1926–27: A Telford gold medal to Sir E. Owen Williams (London), Telford premiums to Dr. E. H. Salmon (London), R. S. Cole (India), Dr. H. Mawson (Liverpool) and A. H. Douglas (London), and a Crampton prize to D. M'Lellan (Glasgow).

M. A. Lacroix, professor of mineralogy at the University of Paris, has been made a foreign member of the Stockholm Academy of Sciences.

At the annual meeting of the American College of Surgeons, Detroit, on October 7, Dr. Franklin H. Martin, Chicago, was elected president-elect, and Drs. John Chalmers DaCosta, Philadelphia, and Herbert P. H. Galloway, Winnipeg, vice-presidents.

Dr. Lewellys F. Barker, professor emeritus of medicine of the Johns Hopkins University School of Medicine, was installed as president of the Interstate Postgraduate Medical Association of North America at the recent annual convention in Kansas City.

Professor D. D. Jackson, head of the department of chemical engineering at Columbia University, has accepted the chairmanship of the coordinating committee, which is in charge of the coming visit of English chemists and chemical engineers, members and guests of the Society of Chemical Industry.

At the recent meeting of the American Röntgen Ray Society in Montreal, Dr. Edward H. Skinner, Kansas City, Mo., was elected *president;* Drs. Ralph D. Leonard, Boston, and Lawrence Reynolds, Detroit, *vice-presidents;* Dr. John T. Murphy, 421 Michigan Street, Toledo, Ohio, *secretary,* and Dr. William A. Evans, Detroit, *treasurer.*

B. F. Dana, assistant professor of plant pathology and assistant plant pathologist in the Experiment Station at the State College of Washington, has accepted a position as plant pathologist in the Texas Experiment Station and is placed in charge of cotton root rot work on substation No. 5 at Temple, Texas.

J. F. Brewster has resigned from the position of research chemist of the Louisiana Sugar Experiment Station, Baton Rouge, La., and has joined the staff of the sugar section, U. S. Bureau of Standards.

Dr. Russell B. Tewksbury has resigned as head of the vital statistics bureau of the Pennsylvania state department of health and has been succeeded by Dr. George B. L. Arner, formerly statistician in the U. S. Department of Agriculture.

Dr. Damaso de Rivas, professor of parasitology, University of Pennsylvania School of Medicine, Philadelphia, goes to the new Pan-American Hospital, New York, as director of pathology. The Pan-American Hospital was dedicated on October 16; the outpatient department opened on October 28.

The following appointments made to the staff of the London School of Hygiene and Tropical Medicine took effect on October 1: Reginald Lovell, to be research assistant in comparative pathology; Mrs. M. M. Smith, to be demonstrator in bacteriology; Miss H. M. Woods, to be assistant lecturer in the division of epidemiology and vital statistics. W. Rees Wright has been appointed to a temporary research post, to continue Dr. P. A. Buxton's investigations on the biology of stegomyia.

George C. Haas, agricultural commissioner in Austria and Germany for the U. S. Bureau of Agricultural Economics, will not resume his Berlin post. At his request an assignment has been given him in the division of statistical and historical research, where he will devote the major part of his time to the extension, development and correlation of the foreign work of the bureau. L. V. Steere, assistant economist, will act in

charge of the Berlin office until Mr. Haas's successor is appointed.

THE malaria survey to be conducted during the coming year through the cooperation of the Jamaican government and the Rockefeller Foundation will be directed by Dr. Mark F. Boyd, director of the Rockefeller Foundation station for field studies in malaria at Edenton, N. C.

DR. D. J. MUSHKETOV, director of the Geological Survey, U. S. S. R., is visiting the United States to gather data on organization, administration, methods of work, publication, costs, etc., in connection with geologic work.

PROFESSOR LEON W. COLLET, professor of geology and formerly dean of the faculty of science at the University of Geneva, Switzerland, will fill Professor R. A. Daly's chair at Harvard University during the first half year and during this month will deliver a course of lectures at Princeton University.

DR. A. C. G. MITCHELL, of the California Institute of Technology, is spending the year in Göttingen in experimental research on atomic structure in the laboratory of Professor James Franck.

DR. TAGE U. H. ELLINGER has returned from Europe where he has been organizing the international corn-borer investigations, instituted under the auspices of the International Livestock Exposition, Chicago. Corn-borer research is under way at ten institutions in the following countries: France, Germany, Hungary, Jugoslavia, Roumania, Sweden and Denmark. During his visit abroad, Dr. Ellinger received from the King of Denmark the appointment and decoration as a Knight of Dannebrog.

DR. HUGH S. CUMMING, surgeon-general of the U. S. Public Health Service, returned to Washington on November 8, after attending the eighth Pan-American Sanitary Conference in Lima, Peru. Dr. Cumming was reelected to his third term of three years as director. Dr. B. J. Lloyd, formerly assistant surgeon-general, will assist him, as heretofore, in the administration of his duties. Dr. Mario G. Libredo, of Cuba, was elected vice-director. At the Peru conference, Dr. Cumming was elected a foreign member of the National Academy of Sciences of Peru.

DR. WILLIAM H. TALIAFERRO, professor of parasitology, Drs. Lucy Graves Taliaferro and Frances A. Coventry, research associates in the department of hygiene and bacteriology of the University of Chicago, have returned from months of research work in Central America. Through the courtesy of the United Fruit Company they spent most of their time working on the serology and immunology of malaria and various intestinal worms at the hospital of the Tela Railroad Company in Tela, Honduras. Dr. Taliaferro has been invited to the school of tropical medicine of the University of Porto Rico to serve as visiting professor of parasitology during the winter quarter of 1928.

PROFESSOR WILLIAM H. HOBBS, of the University of Michigan Greenland Expedition, which left New York last June, returned to the United States on November 8. The expedition has established headquarters at Kangerglugouak Fjord, Greenland, to study weather conditions. Professor Hobbs left five of his associates at Kanderglugouak Fjord to remain until next spring continuing the observations.

DR. W. J. SPILLMAN, economist, division of farm management and costs, U. S. Bureau of Agricultural Economics, has returned to his work in the division after an absence of eight months, during which he studied the agricultural problems of the Indians of the United States.

DR. E. SEIDL, of Berlin, mining engineer and geologist, known for his studies of the salt domes and potash mines of central Germany, is visiting the United States.

DR. LOUIS SHOTRIDGE, Chilkat Indian and assistant in the American section of the University of Pennsylvania Museum, has returned to Philadelphia after five years of ethnological research work in Alaska.

DR. L. LAPIEQUE, professor of physiology in the University of Paris, has been invited to give a series of lectures at the French-Brazilian Interchange Institute, Rio de Janeiro.

DR. WHEELER P. DAVEY, professor of chemistry at Pennsylvania State College, lectured before the Franklin Institute, Philadelphia, on November 10, on "Modern Research on the Structure of Metals."

PROFESSOR A. H. REGINALD BULLER, of the University of Manitoba, is giving a series of six lectures during the week of November 14, on the Norman Wait Harris Foundation of Northwestern University on "Recent Advances in our Knowledge of the Fungi, or the Romance of Fungi Life."

PROFESSOR JAMES E. ACKERT, professor of zoology and parasitologist at the Kansas State Agricultural College, addressed the New Jersey State Poultry Association at Atlantic City on October 13 and the Delaware State Poultry Association at Dover on October 20 on "The Biology and Control of Intestinal Worms of Chickens."

DR. WILLIAM E. GYE, pathologist of the Medical Research Council, London, gave an address on "The

Cancer Problem" on November 8 before the Harvard Medical Society.

DR. GEORGE R. MINOT, of the Harvard Medical School, delivered the eighteenth Mary Scott Newbold lecture at the College of Physicians, Philadelphia, November 2, on "The Treatment of Pernicious Anemia."

DR. C. MACFIE CAMPBELL, professor of psychiatry in the Harvard Medical School, will deliver the eighth Pasteur lecture before the Institute of Medicine of Chicago at the City Club on November 18 on "Some Problems of the Functional Psychoses."

THE Huxley lecture at the University of Birmingham is to be delivered on December 1 by Professor A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge.

PROFESSOR MILTON WHITNEY, chief of the Bureau of Soils, U. S. Department of Agriculture, died on November 11, aged sixty-seven years.

DR. GLENN D. KAMMER, assistant director of the radium research laboratory, Standard Chemical Company, died on November 7, aged thirty-nine years.

DR. G. H. BENJAMIN, industrial engineer of New York, died on November 10, in his seventy-fifth year.

DR. CHARLES E. SIMON, resident lecturer on filterable viruses at the Johns Hopkins School of Hygiene and Public Health, has died at the age of sixty-one years.

JAMES H. DORSETT, formerly collaborating agricultural explorer in the U. S. Bureau of Plant Industry and more recently associated with the National Geographic Society, died in Washington, D. C., on October 8, aged twenty-seven years.

SIR WILLIAM GALLOWAY, mining engineer, known for his pioneer researches into the action of coal dust in mine explosions, died on November 10.

THERE will be an open federal competitive examination for associate chemist at a salary of $3,000 and for a biochemist at a salary of $3,600. Applications must be on file with the Civil Service Commission at Washington, D. C., not later than December 6.

THE twenty-ninth annual meeting (the 148th regular meeting) of the American Physical Society will be held in Nashville from December 28 to 30, in affiliation with section B—physics—of the American Association for the Advancement of Science. At the session in charge of section B, on Wednesday afternoon, December 28, Professor William Duane, the retiring vice-president and chairman of section B, will give the annual address on "The General Radiation." This will be followed by an address by Dr. C. J. Davisson, of the Bell Telephone Laboratories, who will speak on "Diffraction of Electrons by a Crystal of Nickel," a subject of great significance for the new quantum mechanics. This address will be followed by a discussion. On the same afternoon at the general session of the American Association, Dr. E. W. Brown will deliver the Willard Gibbs lecture on "Resonance in the Solar System." On Thursday afternoon, December 29, Professor Karl T. Compton will deliver his presidential address on "Recent Studies of the Electrical Discharges in Gases." Accommodations for members of the Physical Society and of section B have been reserved in the Ward-Belmont School dormitories. Applications for reservations should be sent to Professor C. R. Fountain, care of Ward-Belmont School, Nashville, Tennessee, and should be mailed not later than December 15.

THE twelfth annual meeting of the Optical Society of America was held at Union College, Schenectady, N. Y., on October 20, 21 and 22. Features of the meeting were an address of welcome by President C. E. Richmond, of Union College; a complimentary dinner at the General Electric Company and an inspection tour of research laboratory and plant; an exhibit of optical apparatus by a number of dealers in optical equipment; a banquet at the Hotel Van Curler. Of special interest were the invited papers, "On Cerebral Function in Vision," by Dr. K. S. Lashley; on "Optics, the Key of Astronomy," by Dr. C. G. Abbot, and the presidential address by the retiring president, Dr. W. E. Forsythe, on "Temperature Radiation." At the banquet an interesting demonstration was given by Dr. John B. Taylor of the transmission of music over a beam of light. Eighteen scientific papers and reports were read. The following officers were elected for a term of two years, beginning January 1, 1928: *President,* I. G. Priest; *vice-president,* L. A. Jones; *members of the executive council,* L. R. Ingersoll, P. E. Klopsteg, W. F. Meggers, A. H. Pfund.

IN addition to the fifteen papers to be presented at the organic symposium of the American Chemical Society at Columbus, Ohio, from December 29 to 31, there will be colloquia on the following subjects. Suggestions regarding them should be sent to the chairmen in charge. "Abstracting Organic Articles," E. J. Crane, *chairman,* Ohio State University, Columbus, Ohio; "Electronic Conceptions in Organic Chemistry," H. S. Fry, *chairman,* University of Cincinnati, Cincinnati, Ohio; "An Organic Experience Meeting," L. F. Fieser, *chairman,* Bryn Mawr College, Bryn Mawr, Pennsylvania; "Nomenclature of Organic Chemistry," A. M. Patterson, *chairman,* Xenia, Ohio; "Teaching Organic Chemistry," F. B.

Dains, *chairman*, University of Kansas, Lawrence, Kansas.

On Saturday evening, November 19, the New York Microscopical Society will hold its fiftieth anniversary at the American Museum of Natural History. The exhibition will consist of mounted objects under instruments, microscopes—ancient and modern, apparatus, accessories, books and other material of interest to the microscopist.

The regular fall meeting of the New York section of the American Electrochemical Society will be held at Keen's Chop House, New York City, on November 18, at 6:30 p. m. Mr. G. A. Anderegg, of the Bell Telephone Laboratories, will speak on "Submarine Cable Engineering."

The North American Committee on Fishery Investigations held its autumn meeting on October 19 at the University of Toronto. The United States was represented by Dr. H. B. Bigelow, of Harvard University, and Elmer Higgins and O. E. Sette, of the U. S. Bureau of Fisheries. The haddock fishery was given particular attention. Study of the total catch made on this side of the Atlantic reveals that there has been, on the whole, little change since as far back as the eighties of the last century, though a slow increase since 1900 is evident.

On the occasion of the International Conference on Rabies, recently held in Paris, an International Society for Microbiology was founded, with Professor Jules Bordet, of Brussels, as president, and Professor Rudolf Kraus, of Vienna; Drs. Dujarric de la Rivière and Plötz, of Paris, as secretaries.

In the presence of leaders of European chemistry, M. Herriot, minister of public instruction, laid on October 26 the corner-stone of the International House of Chemistry, to be erected in Paris at a cost of 15,000,000 francs as a memorial to Marcelin Berthelot. Jean Gerard, secretary-general of the French Society of Industrial Chemistry and head of the French committee in charge of raising funds, has succeeded in obtaining subscriptions from forty nations for the aggregate sum of 15,538,000 francs, 8,700,000 of which has been given by France. The United States was the fifth largest contributor on the list with 583,400 francs.

The will of the late William John Curtis, of New York City, provides $10,000 to the New York Otological Society for its research fund and $10,000 to the Johns Hopkins University Medical School. Bowdoin College will eventually inherit $55,000 from two trust funds established for the testator's sister.

Through the generosity of his surviving colleagues, the photographic collection of the late Erwin F. Smith, of the U. S. Department of Agriculture, has come into the possession of Science Service. The collection consists of more than 200 portrait negatives, largely of plant pathologists, but including a considerable number of portraits of historic value. With the negatives were also a large number of photographic prints, partly from the plates and partly from other sources. The work of cataloging negatives and prints is now going forward. All of the original photographs, together with a complete set of prints from negatives, will be deposited with the library of the Department of Agriculture after they have been properly arranged and labeled. The negatives will be retained by Science Service, and a special catalogue will be issued to enable interested persons to obtain such prints as they may desire.

UNIVERSITY AND EDUCATIONAL NOTES

A gift of $25,000 has been made to Harvard University by Mr. George R. Agassiz to endow a research fellowship for advanced students at the Harvard College Observatory.

The Sloane physics laboratory at Yale University has purchased important additional equipment as a result of a gift of $26,000 made during the past year by Henry T. Sloane, of New York City.

The Rockefeller Foundation has given $1,640,000 to the department of medicine of the University of Lyons, which is being removed to the suburb of Monplaisir, close to Grange Blanche Hospital. Of the remaining 15,000,000 francs required, Premier Poincaré and Minister of Instruction Edouard Herriot have promised to supply 12,000,000 francs in three instalments from government appropriations, the university will supply 1,500,000 francs and prominent citizens of Lyons will be asked to donate the remainder.

Dr. William H. Cole, professor of biology at Clark University, has been appointed professor of physiology and biochemistry at Rutgers University, where he will begin his work on February 1. His associate, Dr. Allison, will offer the courses in biochemistry.

John Wolfenden, a graduate at Oxford and last year a fellow of the Commonwealth Fund at Princeton University, has become acting assistant professor of chemistry at Oberlin College.

Dr. John Beattie, recently prosector in the Zoological Gardens, London, England, has been appointed assistant professor of anatomy at the University of Montreal.

R. Herbert Edee has left Northwestern University

to become professor of organic chemistry at Hamline University, St. Paul, Minnesota.

Edwin H. Shaw, Jr., has been appointed assistant professor of biochemistry at the University of South Dakota, Vermillion, S. D.

Dr. H. C. Jackson, associate dairy manufacturing specialist of the Bureau of Dairy Industry, at present in charge of the department's experimental work at the Grove City creamery, has accepted appointment as head of the dairy department in the College of Agriculture of the University of Wisconsin.

R. R. McKibbin, assistant professor, soils department, University of Maryland, has been appointed lecturer in the department of chemistry in Macdonald College, Quebec, Canada.

Assistant Professor W. W. Elliott has been promoted to a professorship of mathematics at Duke University.

Professor Zwaardemaker, occupant of the chair of physiology at the University of Utrecht, has resigned his post, having reached the age limit. He will be succeeded by Professor Noyons, of Louvain, Belgium.

DISCUSSION AND CORRESPONDENCE

A COMMUNICATION ON THE MAGNETO-OPTICAL EFFECT AND A CORRECTION

This article concerns the Magneto-Optical Effect, described by me in Science (N. S. Vol. LIII, No. 1382, pp. 565 to 569, June 24, 1921) and *Nature*, June 23, 1921, which was at that time a novel discovery or observation. The description was later followed by a statement of "Further Investigations," (Science, N. S. Vol. LIV, No. 1387, pages 84–85, July 29, 1921).

In the first place, I desire to make a correction in the latter communication, where it is stated that the "flickering observed appears to keep time with the *cycles* and not with the *alternations of current.*" This is an error, as it was found later that in reality the described fluctuations do indeed follow the alternations, the mistake being due to misinformation as to the cyclic rate.

It may be desirable here to describe briefly the original phenomena, adding comments which relate to more recently observed facts. A magnetic field produced by a direct current, permanent magnet, or by interruptions or alternations of current is rendered visible even when very weak, by a light smoke from an iron arc. Such fume or smoke is effective for the purpose even when so thin or diffused as to be scarcely noticeable in the air. Such smoke, too, diffused in the space where a field exists, when illuminated from above by sunlight or an artificial source, and viewed in a direction across the light beam, and more or less normal to the direction of the lines of force of the field apparently becomes luminous. In reality it becomes a far better reflector or diffuser in certain directions of the incident light than when the field lines are absent. Viewed along the magnetic lines no increased luminosity is produced even when the field is strong or the illumination strong, or both.

The conditions for its observation seem to be—

1. Illumination transverse (more or less) to the direction of the lines of force of the field.

2. Viewing in a direction more or less transverse to the lines of the field and to the direction of the incident light.

The amount of iron smoke in the air required to produce a very noticeable effect seems to be very small, although density of the smoke increases greatly the contrast between what is visible when current or field is on, and when no magnetic field exists. Indeed, without the presence of the field the smoke from the iron arc may be practically invisible. The illumination from the smoke particles was found to be polarized as if produced by reflection from strings of fine particles, oriented in the direction of the field lines. These particles are exceedingly small, almost beyond ordinary high powers of the microscope, and the striated ferric oxide, which it seems to be can be caught on a microscope slide while the magnetic field is on, and studied under high powers.

The remarkable thing is the small amount of the iron smoke needed to produce the effect and the instantaneous response to very weak fields. Thus, if an open coil or helix without a core of iron be traversed by a fluctuating or slowly alternating current, the flickering may be shown by a detector constituted by holding the open neck of a glass flask over an iron arc for a few moments. Some of the smoke enters the flask, which can then be corked. Such a flask has shown flickering at a distance of twelve feet away from a small coil, through which a low frequency current was sent. And, curiously, when the flask was placed near the coil the flickering was replaced by a steady illumination. When gradually removed from the coil in the direction of its axis, the flickering became more and more pronounced.

This indicates that the orientation or arrangement of the particles to correspond with the field lines, takes place with a weak field, and almost instantaneously in a strong alternating field; in the latter case, being accomplished and maintained throughout the whole wave of current. The zeros seem to be without effect in arresting the appearance, while at a considerable distance away from the same coil, excited as before, the weaker field at such a distance

can only orient the particles at or near the maximum of the current waves. This seems to indicate that a certain very low value of the magnetizing force is sufficient for the orientation or alignment of the particles. Retention of vision by the eye may also cover up any very short interruptions in the luminous effect itself.

Use has been made, since the publication of the original descriptions, of the new effect for rendering visible to the eye a rotating field produced by biphase, three phase, or polyphase currents. The effect is unique, and naturally quite interesting. It can be photographed.

If we provide a box with a glass front and back and means for introducing the iron arc smoke, a beam of light sent in from the back with no excitation or magnetic field present, there is no marked result. We may now place on the box a coil lying flat on the top and conveying current. In this case there is clearly displayed a luminous effect; the field of the soil has been depicted. In each case, of course, iron arc smoke has been within the box at each trial. It can be allowed to enter through a hole at the bottom of the box provided therefor.

It is surprising, too, how long a time it takes for the fumes to settle out of the air within the apparatus.

We have constructed a device for rendering visible a rotating field, such as that of a three-phase motor. The structure is, in fact, a three-phase field winding, as in a motor. As the ordinary frequencies would be too high for observation, there is provided a small motor driving at reduced speed a small generator of the three-phase currents needed for the excitation of the field. Usual arrangements are provided for varying the speeds, and thus the cyclic rate or frequency of the currents in three-phase winding. The open field space, as in an alternating current motor with the rotor removed, is arranged with glass ends so that it may receive and retain iron arc smoke. In this way, the revolving field inside the structure becomes distinctly visible as a luminous glow revolving within it.

The direction of revolution may also be instantly changed by the switches provided for reversing two of the phases, and the speed of revolution of the field may be made slow, or so fast that retention of vision results in a continued interior luminosity.

It is probable that with further development such arrangements may be designed as to make use of this magneto-optical phenomenon in the study of distortions in alternating fields by the introduction of closed circuits in the form of rings, plates and various forms of conductors, or even to compare the distortions produced by the material as well as the form of conductors in alternating fields. Perhaps, also, the distortions of field lines produced by revolving or moving conductors even in direct current fields may be exhibited or investigated. My time has not permitted such work, interesting as it may be, to be carried on.

ELIHU THOMSON

THE EUROPEAN LARCH CANKER IN AMERICA[1]

IN April, 1927, members of the Harvard Forest School brought to the senior writer's attention specimens of a trunk of European larch bearing several cankers in the thin smooth bark of the younger parts. The appearance instantly suggested the European larch canker disease and it was quite evident that it was acting as a parasite. Fortunately perfect fruiting bodies were present and the fungus was found to agree in general with the microscopic characters published for *Dasyscypha calycina* (Schum.) Fuckel. Examination of the plantation from which the specimen came showed abundance of cankered trunks and branches. The fungus occurred on dead twigs and branches as well as on living bark of younger parts of the trees. Since that time investigations have been carried on to determine how serious the disease is, and how extensively it is distributed in that vicinity. It has been found attacking European larch (*Larix europaea* DC.), Japanese larch (*L. leptolepis* Gordon), eastern American larch (*L. laricina* (DuRoi) Koch), Douglas fir (*Pseudotsuga taxifolia* (LaMarck) Britton), pitch pine (*Pinus rigida* Miller) and Scotch pine (*P. sylvestris* Linn.) and on four different estates situated in the three towns, Hamilton, Ipswich and Danvers, Massachusetts. In Europe it is reported to attack the additional species which are native or generally introduced here; *Larix occidentalis* Nuttall, *L. sibirica* Ledebour, *Picea excelsa* Link, *P. sitchensis* Carrière, *Pinus nigra austriaca* Asch. & Graeb., *P. cembra* Linnaeus, *P. laricio* Poiret, *P. mugho pumilio* Zenari and *Abies pectinata* DC. The origin of the disease is quite conclusively indicated by the fact that the European and Japanese larches on two of the estates were imported as seedlings from Scotland in 1904 and 1907. Old cankers are located within a foot of the ground on wood which must have been formed when the trees were imported. Some of the diseased Douglas fir is also known to have been imported as seedlings. The amount of infection in European larch runs up to one hundred per cent. of the trees; Japanese larch is relatively resistant, but Douglas fir infection near diseased European larch is about eighty per cent., with

[1] Published by permission of the U. S. Secretary of Agriculture.

numerous cankers similar to those on the larch. There is no reason to suppose that this locality is the only one where the disease occurs; indeed the reverse is practically sure to be the case, as it is well known that European larch was imported widely and quite generally twenty to fifty years ago. The fact that it can go onto so many different American species, which are important timber trees, makes this discovery of very serious importance to all parts of this country. Further scouting is being done to see if it is widely distributed.

PERLEY SPAULDING,
PAUL V. SIGGERS
BUREAU OF PLANT INDUSTRY AND
NORTHEASTERN FOREST EXPERIMENT STATION

THE DEFICIENCY OF ENGLISH UNITS OF MEASURE AND WEIGHT FOR SCIENTIFIC AND TECHNICAL USES

THERE are certain deficiencies in the English measures and weights which may be ascribed to historical causes and which have been imperfectly supplied by the use of troy and metric small denomination units. But the troy and metric units are not commensurable with the common or English units. The cause of this deficiency is that the English units were developed for the uses of trade, construction and manufacture, to which purposes they are perfectly adapted. The demand for technical, scientific and precision units is a relatively modern demand.

The English measures have no unit lower than the inch, whereas the metric system has seven such units, *viz.*, centimeters, millimeters, microns, angstroms, millimicrons, milliangstroms and micromicrons, of which the inch contains 2.54 centimeters, 25.4 millimeters, 25,400 microns, 254,000 angstroms, 25,400,000 millimicrons, 254,000,000 milliangstroms and 25,400,000,000 micromicrons.

Likewise the English weights have no unit lower than the ounce, whereas the troy and metric weights have 12 such units, *viz.*, drams, pennyweights, scruples, grams, carats, metric carats, decigrams, grains, centigrams, milligrams and micrograms, of which the ounce contains 7.2916 drams, 18.229 pennyweights, 21.875 scruples, 28.3502 grams, 138.449 carats, 142.045 metric carats, 437.5 grains, 2835.02 centigrams, 28,350.2 milligrams and 28,350,200 micrograms.

To supply the deficiency of our common units in the field of technical and scientific measures and weights, it is proposed that the foot be divided on the decimal scale into 100 lines and 1,000 points and that the ounce be divided into 8 drams, 100 centos and 1,000 moits, the ounce being the cube of the tenth of the foot, the dram the cube of the twentieth of the foot and the moit the cube of the hundredth of the foot of water at the maximum density. The common eight-ounce cup is the cube of two tenths or of one fifth of the foot. This will supply the deficiency of common units lower than the inch and the ounce, made necessary by modern refinements in measuring dimensions, volumes and masses.

For definitive purposes it is proposed that the foot be taken as the length of 473,404 waves of red cadmium light, that the ounce be taken as the weight of 28,316 milligrams and that new material standards or master bars and weights be constructed from these definitive values.

The avoirdupois pound was anciently regarded as equal to 7,002 troy grains. In 1844, however, after the burning of the parliamentary standards, the pound for the sake of certainty was defined by parliament as the weight of 7,000 troy grains, which produces 437.5 grains to the ounce.

The proposal to define ounce as 28,316 milligrams recognizes 28,316 grams as the weight of the cubic foot of water under the definition of the foot as 473,404 red cadmium waves. This takes 34 milligrams off the ounce, which for practical purposes may be regarded as one-half grain of 32.4 milligrams, thus reducing the ounce roughly from 437½ to 437 grains.

It is quite as legitimate to give the ounce a definition in milligrams as it was to give the pound a definition in troy grains, as was done more than eighty years ago. This is the one way to coordinate the ounce with the cubic foot of water and to correlate common volumes and weights.

SAMUEL RUSSELL
WASHINGTON, D. C.

"WASHBOARD" OR "CORDUROY" EFFECT DUE TO THE TRAVEL OF AUTOMOBILES OVER DIRT ROADS

THE interesting account of the so-called "washboard" or "corduroy" effect due to the travel of automobiles over dirt roads calls to mind an experience which the writer had last summer in the northern part of Minnesota.[1] Professor Dodd's explanation is very much to the point and on the whole I think plausible, but I am not sure that the explanation has gone far enough. In the single instance observed, my motor car was following a "grader" over a newly graveled stretch of road and, since I had myself advanced several theories concerning the cause of this

[1] Dodd, L. E., "'Washboard' or 'Corduroy' Effect Due to the Travel of Automobiles over Dirt Roads," SCIENCE 66, 1927, 214–216.

frequent phenomenon, I was very much interested to see that my theories were wrong, especially at the beginning of the causal series. Many of the corrugations that I had noticed were somewhat slanting, and now I saw that the scraping blade of the grading machine was responsible for the original vibration which was left in the road.

I have no doubt that the wheels of cars which travel on newly graded roads very much deepen these ridges when they resonate in tune to the original vibration of the scraping blade of steel which has left its marks in the ridges on the road. It must not be forgotten, too, that rain falling on the road will then also tend to drain off along these ridges and deepen them by erosion. I am wondering, too, when the road is of a certain elastic consistency, with a slight amount of moisture in the top layer, whether it will not then act much in the same fashion as the black asphalt pavements do when they are corrugated by impact, especially on down grades.

Naturally, this was only a single instance that came under my observation, but I made sure that there were no corrugations in front of the grader and that there were characteristically slanting and partially formed ones behind, and I am offering this bit of discussion in the hope that the matter may be verified or contradicted by observations of others. In general, this additional cause does not contradict the excellent explanation of Professor Dodd, but goes simply one step farther in certain cases.

CHRISTIAN A. RUCKMICK
THE UNIVERSITY OF IOWA

THE SEARCH FOR ELEMENTS ESSENTIAL IN ONLY SMALL AMOUNTS FOR PLANT GROWTH

FOR many years the essential nature of certain elements for normal plant growth remained undiscovered because they are needed in such small amounts that they were supplied as undetected impurities in the media in which the plants were grown. Between the years 1910 and 1919 Mazé,[1] by careful technique, showed boron, zinc and manganese to be essential to the growth of maize. Possibly because most of his papers were published in a journal devoted chiefly to bacteriological literature, they were overlooked by most plant physiologists. It was not until 1922 that the work of McHargue[2] emphasized the essential nature of manganese.

Boron was the next of these elements to receive attention. Warrington[3] in 1923, showed it to be essential for broad beans (*Vicia Faba*) and probably for runner beans, crimson clover (*Trifolium incarnatum*) and *Trifolium multiflorus*, but reported inconclusive results for white clover (*Trifolium repens*) and peas and negative results for barley and rye. The writer[4] in experiments with silicon and aluminum in which purified salts were used, confirmed the results with broad beans. The "mason" jars in which the solution culture experiments were being carried out were coated with "Valspar," a resistant varnish, to prevent contamination by solution of the glass, and sufficient boron for apparently normal growth of wheat, peas, millet and *Penisitum vilosum* was furnished by the varnish. Broad beans, however, made very little growth and showed the symptoms described by Warrington. They made remarkable recovery and normal growth when .5 mg. per liter of boron as boric acid was added to the solution. Later on when using uncoated jars in an experiment to determine whether or not chlorine is essential to plant growth, buckwheat failed to develop beyond the cotyledon stage when purified salts were used but developed normally when the ordinary "C.P." analyzed salts were employed. Because of the experience with broad beans, absence of boron was suspected of being the limiting factor. Investigation showed this to be the case. This and the effect of boron on the growth of sunflowers led the writer to study the effect of the absence of boron on a number of plants. Part of this work[5] with that continued at the University of California and later at the University of Minnesota, showed boron to be essential to corn, peas, sunflowers, vetch, barley, buckwheat, dahlias, lettuce, potatoes, millet, castor beans, sugar beets, kafir, sorghum, flax, mustard and pumpkins. Plants differed in the time, and to some extent in the way, in which the effect first appeared but none of the plants reached the flowering stage. Dicotyledonous plants in general responded more quickly than did monocotyledonous plants. In the case of sunflowers, cotton and buckwheat, the tops did not develop beyond the cotyledon stage and the roots grew very little. Other dicotyledonous plants showed the lack of boron by suppressed roots with enlarged apices within a few days but, depending on the type of plant, produced from

[1] Mazé, P. *Ann. Inst. Pasteur.* 1914, 28, 21–68; 1919, 33, 139–173. *Comp. Rend. Acad. Sci.* 1915, 160, 211–214.

[2] McHargue, J. S. *Jour. Amer. Chem. Soc.* 1922, 44, 1592–1598.

[3] Warrington, Katherine. *Ann. Bot.* 1923, 37, 629–672.

[4] Sommer, A. L. *Agri. Sci. Series*, Univ. California. 1926.

[5] Sommer, A. L. and Lipman, C. B. *Plant Phys.* 1926, 1, 231–249.

two to eight leaves. Soy beans were an exception; neither the tops nor the roots showed the effects of the lack of boron for two weeks. In this case also the roots were the first to show the effect. Monocotyledonous plants grew for a greater length of time and produced much better root systems than did the dicotyledonous plants. Many of these plants showed abnormal tillering as well as withering of the growing points of the tops. Corn showed the effects of the lack of boron in a week, but continued to produce small tillers for some time. Barley, under winter greenhouse conditions, apparently grew normally for a month, but after that the difference between the plants without boron and the controls developed rapidly. Bermuda grass (the only plant investigated which did not show marked injury in the absence of boron) is still under investigation, and so far has given very doubtful results. It is a very resistant grass and after an initial addition of iron to the culture solution, grew well and with no signs of chlorosis, without further additions of iron, during a period of two months while the writer was absent.

It is interesting to note that in a recent paper by Brenchley and Warrington,[6] buckwheat and potatoes are among the plants reported to have given inconclusive results and that peas completed normal development without boron. These results, as well as some reported in Warrington's earlier paper, are in marked contrast to those obtained by the writer. Whether this is due to a difference in technique or to the amount of boron stored in the seed is a point still to be investigated, but the fact that these authors obtained better growth without the addition of boron when they changed the solutions frequently suggests that the salts which they used may not have been entirely free from boron. In the case of the potato, the writer did not use seeds but allowed the tubers to sprout, removed the sprouts and transferred them to culture solutions.

Zinc, of the three elements mentioned above, is the one in which the conditions of experimentation must be most carefully controlled. The ordinary glass "mason" jar, in which many solution culture experiments are carried out, apparently furnishes all the zinc the plant needs. It was not until an attempt was made to use pyrex beakers with purified salts that the need of zinc was suspected. Solutions of the same salts which had produced good plants in ordinary glass failed when pyrex was employed. Wheat grew well for about two weeks and then stopped growing, turned yellow and finally died. The roots on the other hand were in good condition when the tops were dry and apparently dead. The analyses published by McHargue[7] in which zinc was found in seeds led the writer to try zinc which was found to be the limiting factor. It was not until the experiments with barley and sunflowers were completed that the paper by Mazé, in which he showed zinc to be essential for maize, was discovered in the literature. As in the case of the lack of boron, recovery from the lack of zinc can be accomplished by the addition of .5 mg. of the missing element per liter to the culture solution. Smaller quantities may be sufficient, but were not tried.

Zinc was shown to be necessary for barley, sunflowers, wheat, buckwheat, broad beans and red kidney beans. Buckwheat, sunflowers, barley and wheat showed the effects of the absence of zinc in the early stages of growth; wheat and barley died in the early stages, while some of the sunflowers and buckwheat plants, although much smaller than the controls, produced a few small flowers. The broad beans and red kidney beans without zinc appeared to grow as well as the controls until they reached the flowering stage. At this stage, the plants declined rapidly; most of the leaves fell off and only a few flowers on the broad beans developed. No seed was produced by the plants without zinc, while those with zinc developed normally.

When pyrex glass was used, silicon and aluminum, and later traces of other elements, including copper, were added to the solution. Barley failed to make good growth in pyrex containers unless silicon was added and there was some indication that copper is also necessary.

A study of these problems has shown that it is only by exercising the greatest precautions that we may solve the problem of essential elements. The salts must be repeatedly crystallized from pure distilled water (essentially conductivity water) and in some cases be derived from elements and acids or from other salts, for the "C.P." salts of trade usually contain, as impurities, sufficient amounts of certain elements to produce normal plant growth. Contamination by dust and in some cases other impurities in the air (for example, chlorine, in chlorine studies) must be carefully avoided. The type of container is also an essential factor. The ordinary glass jar must be avoided in many cases because of its solubility. Pyrex is suitable for most work, and, although a boro-silicate, does not yield sufficient silicon and boron for the normal growth of at least some plants. The effect of the lack of boron, how-

[6] Brenchley, W. E. and Warrington, Katherine. *Ann. Bot.* 1927, 41, 167–187.

[7] McHargue, J. S. *Jour. Amer. Soc. Agron.* 1925, 17, 368–372.

ever, appears more slowly than when ordinary glass is used. Containers other than glass will probably have to be employed before the whole problem of essential elements is solved.

A. L. Sommer

University of Minnesota

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONTAINER FOR FIELD COLLECTION OF MOSQUITO LARVAE

In the prosecution of malarial or mosquito studies larval collections play no small part. Containers used for captured larvae are subject to various disadvantages. For example, if the collecting jar is kept closed during field operations, the cover or cork must be removed whenever specimens are transferred to the container. If left open the contents are often lost because of jarring, especially if one is collecting in an area of irregular topography. Furthermore, most containers used for this purpose have either no mechanism for their attachment to the belt, or only an inadequate arrangement. The apparatus described below was devised to overcome the disadvantages just cited.

The container is a four-ounce jar with a mouth diameter of 40 mm. Two glass tubes with inner diameters of 4.5 mm. and 1.5 mm. run vertically through the rubber stopper as shown in the illustration. The outer termination of the former is flared

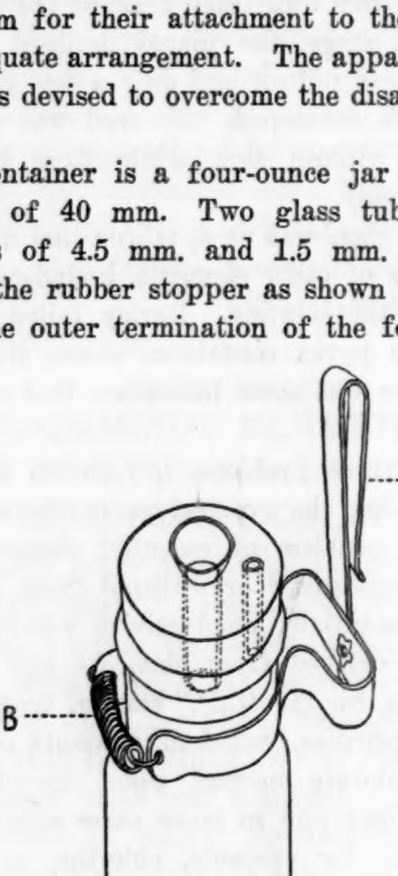

Fig. 1

into a funnel with a maximum diameter of 15 mm. and height not exceeding 10 mm. The inner end is flush with the surface of the stopper. The shorter the height of the protruding funnel the less will be the risk of breakage. The widened portion facilitates the transfer of larvae from the dipper in which they were captured, to the receptacle, by means of a pipette. The smaller tube practically prevents the formation of air bubbles in the larger. Its inner termination extends slightly beyond the stopper to prevent particles of the rubber cork from filling the tube and thus hindering air circulation.

The bent portion (A) made of nickel plated metal served to hold a key ring to a belt. It is now used for a similar purpose except that it is riveted to the collar, a piece of spring steel 13 mm. wide, so constructed that the jar is held tightly in place when its neck is enclosed within the collar. A hook similar to that shown in the illustration, except that it extended upward from the lower part of A, was cut off to better adapt the remainder for the design in view. The coiled spring (B), while not necessary, renders slipping of the jar impossible. All metallic parts should preferably consist of rust resisting material.

The apparatus after several months' trial in Porto Rico has proven fairly satisfactory. It is hoped that this descriptive note will stimulate others to improve the present model.

Wm. A. Hoffman

School of Tropical Medicine
of the University of Porto Rico,
Under the Auspices of
Columbia University,
San Juan

DECALCIFICATION OF BONE IN ACID FREE SOLUTIONS

In attempting to develop a method for the determination of an orthophosphate in bone, one of us observed that tertiary calcium phosphate is dissolved on addition of an excess of a magnesium citrate reagent even in the presence of a large excess of concentrated ammonia. White,[1] some four years ago, suggested the use of a solution of ammonium citrate for removing the lime salts from bone and the solvent action of the magnesium citrate reagent upon tertiary calcium phosphate suggested to us its possibilities as a decalcifying agent for histological purposes. The attempt to decalcify osseous tissue by means of this reagent proved successful.

The reagent is prepared as follows: Dissolve 80 gm of citric acid in 100 cc of hot water. Add 4 gm of magnesium oxide and stir until dissolved. Cool, and add 100 cc of ammonium hydroxide (density 0.90). Dilute to 300 cc, let stand 24 hours and filter. (If the magnesium oxide contains much carbonate, it

[1] White, C. P., *Jour. of Path. and Bact.*, Vol. 26, No. 3, 1923.

should be freshly ignited.[2]) The solution remains clear for some time and on standing, more rapidly after agitation, crystals of ammonium magnesium phosphate make their appearance.

Titrate with 5/N HCl to a reaction of approximately pH 7.0–7.6 and add an equal volume of distilled water.

Procedure and results.—This decalcifying fluid is apparently efficient in softening bone after it has undergone the action of any of the common fixing agents, but it is perhaps better to fix and harden the specimen in formalin. The latter must be well washed out from the tissue, first in running water for 12–24 hours according to the size of the specimen, and then in two or three changes of distilled water. It is then ready for decalcification. The citrate solution should be changed fairly frequently, since it will otherwise dissolve the calcium salts to saturation and the reaction will then retard. It has seemed best to replace the solution every other day. Decalcification proceeds relatively slowly as compared with solutions of the strong acids such as hydrochloric or nitric but it is much more rapid than Muller's fluid, picric or chromoacetoosmic acid, for example. The rib of a dog split through the center is freed of lime salts by this solution in about fifteen days. Swelling of the tissues is not induced by the fluid and there is no apparent shrinkage of such cells as those of the bone marrow. Stains are taken up without difficulty and sections stained with haematoxylin and Eosin colored in tints much more pleasing to the eye than those obtained when the application of the stain has been preceded by decalcification with strong acids. Magnesium citrate solutions are not so satisfactory as is Muller's fluid, however, if determination of the amount of uncalcified osteoid tissue present in the bone during the life is requisite. Unlike Muller's fluid, magnesium citrate allows decalcification to go on to completion and removes all possibility of distinguishing the osteoid tissue from bone which in life contained deposits of lime.

[2] This reagent has been used by Mathison, G. C., *Biochem. Jour.*, 1909, IV, 237; Fiske, C. H., *Jour. Biol. Chem.*, 1921, XLVI, 289, and by others.

Conclusions. 1. Bone may be completely and rapidly decalcified by means of a reagent which is neutral or alkaline and is free of acids. 2. This process leaves the remaining tissues in a satisfactory degree of preservation.

B. KRAMER,
P. G. SHIPLEY

THE JOHNS HOPKINS HOSPITAL

SPECIAL ARTICLES

E.M.F. INDUCED IN A STRAIGHT WIRE BY A CURRENT IN A PARALLEL STRAIGHT CONDUCTOR

IN Figure 1, let A be a cross-section of a tubular conductor of practically infinite length, and let a current, i, in this conductor flow "in," as shown by the crosses. Another long conductor, B, of small cross-section, is placed along the geometrical axis of A, and the ends of B are left open. It is required to compute the e.m.f. induced in B, per unit of its length, when the current in A varies with time at the rate di/dt.

Reasoning I. The magnetic lines of force outside the tube A are concentric circles, such as H. Within the wall of the tube they are also concentric circles. Inside the tube, the magnetic flux density is zero at any value of i. Consequently, no flux cuts B or collapses on it when the current i is varied, and no e.m.f. is induced in B.

Reasoning II. Consider two diametrically opposite filaments of current, such as f and f′, and determine the e.m.f. which a varying current in these filaments would induce in B. The three conductors are shown separately in Fig. 2. Let h be a line of force due to f, and h′ a line of force due to f′. Let the currents in f and f′ decrease; the motion of the two fluxes is then as shown by the horizontal arrowheads, each flux "collapsing" towards its own conductor. With

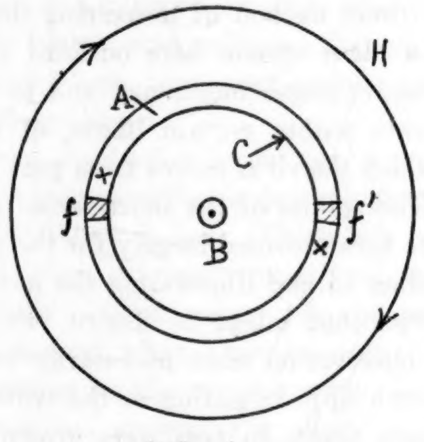

Fig. 1.

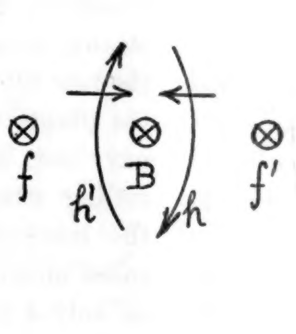

Fig. 2.

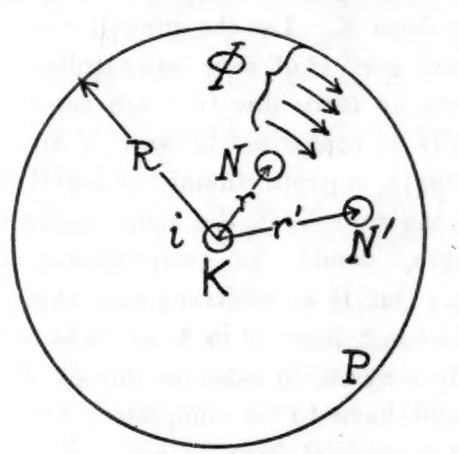

Fig. 3.

the polarities shown, the direction of the e.m.f. induced in B is "in," as indicated by the cross, the filaments f and f′ acting concurrently. This agrees with the general law that when the primary current decreases, the secondary induced e.m.f. is in the same direction as the primary current.

The tube A may be considered as consisting of pairs of filaments, such as f and f′. Since an elementary e.m.f. is induced in B by each pair of filaments, and the action is cumulative, a finite e.m.f. should be induced in B when di/dt in the whole tube has a finite value.

Thus, according to Reasoning I, there should be no e.m.f. induced in B, while according to Reasoning II, there should be an induced e.m.f. of finite value. Before unraveling this seeming paradox, the following propositions should be considered:

(1) Is it legitimate to speak of an e.m.f. induced between the open ends of a long straight conductor? To measure this e.m.f. it would be necessary to introduce leads to a voltmeter, thus forming a closed circuit. If an electrometer be used instead, the circuit would still be closed through electrostatic lines of force within the instrument. Should the leads and the measuring instrument be placed within the tubular conductor A, there should be no indication when the current i is varied. Should the instrument and the leads be placed outside A, a loop would be formed, linking with some of the external flux H, and the induced e.m.f. would depend upon the total flux enclosed by the loop.

(2) Careful writers do not speak of an e.m.f. induced in an open straight secondary conductor, but of the direction of the secondary current. This implies a closed secondary circuit and avoids the vexed question as to the seat and location of this e.m.f. See, for example, J. C. Maxwell, *Electricity and Magnetism,* Vol. II, p. 178; Foster and Porter, *Electricity and Magnetism,* p. 394.

(3) In Fig. 3, let K be a straight infinite conductor carrying a current i. Let N be a parallel secondary conductor of finite length, with open ends, at a distance r from K. Let the current i return through a cylindrical shell P of very large radius R.

The lines of force due to i are concentric circles, and the flux Φ, comprised between N and P, per unit of axial length, is proportional to $i \log(R/r)$. Should i vary at the rate di/dt, the e.m.f. induced in N, per unit length, would be proportional to $(di/dt) \log(R/r)$. But R is arbitrary and tends to infinity, so that the e.m.f. induced in N seems to be indefinitely large. Here again, to measure this e.m.f., the circuit of N would have to be completed, for example by means of a parallel wire N′, at a distance r′. The flux enclosed in this secondary loop has a finite value, proportional to $i \log(r'/r)$, and the e.m.f. induced in the loop (not in one of the conductors) has a definite value (finite) confirmed by experiment.

(4) If an e.m.f. could be induced in a long straight secondary conductor, as shown in Figures 1 and 3, then by grounding one end and providing the other end with a sharp point, an intense local electrostatic field should be produced. The existence of this field could perhaps be demonstrated by some delicate ionization experiment, Stark effect, etc. On the other hand, grounding one end would give a closed circuit, through displacement currents along lines of force between the sharp point and the ground, so that the experiment may not be conclusive.

Thus, on the whole, it seems as though the foregoing paradox is based on the impossibility of either computing or measuring an e.m.f. induced in an open conductor, without considering a return circuit of some kind, either conducting or through a dielectric. In view of the very fundamental nature of the phenomena and laws involved, it is hoped that other points of view will be contributed to this discussion.

Vladimir Karapetoff

Cornell University

RATE OF VIRUS SPREAD IN TOMATO PLANTS

When a plant is inoculated at one point with a virus disease, at what rate does the infective principle diffuse itself to other stems, leaves or shoots? Assuming that the incubation period is constant—that symptoms will appear in a given time after the infective agent has reached any point—the appearance of symptoms in a succession in other portions of the plant distant from the point of inoculation ought to provide a measure of the rate of virus spread from the original inoculation point. This observational method, however, relies on uniformity of growth in all parts of the plant and such uniformity may not exist; it further depends on the detection of symptoms at the same stage in their development, which is by no means a certain procedure.

The more direct method of measuring the progress of virus in a plant system here outlined appears to avoid the disadvantages mentioned and to provide a means, accurate within certain limits, of measuring the rate at which the virus moves from part to part of the plant. The results of the short series of preliminary tests are here recorded largely for the purpose of calling attention to and illustrating the method, since the conclusions that might be drawn from the few cases under observation must necessarily be accepted as only a rough approximation to the truth.

Eight tomato plants in pots were grown in such a manner as to develop several horizontal branches, each

of which was bent and led under the earth in a secondary pot to encourage rooting and thus form a readily detachable second plant. The rooting process was hastened by a partial cut between the original and secondary pots. There was thus produced a "colony" with all its units organically connected but capable of being separated at any time and in any fashion desired. The colonies were grown in a greenhouse under a close cheese-cloth cage. The greatest care was taken throughout to avoid accidental infection through insects, handling, touching of leaves, watering, etc. There is no evidence that any such accidental infection occurred anywhere in the series.

When all secondary plants were well rooted but still attached to the parent plant a single shoot of the parent was inoculated with freshly expressed juice from tomato leaves showing marked mosaic. A glass tube drawn to a capillary point was used for the purpose, pressure being supplied by means of a dropper bulb on the end. Inoculations were made near the growing point.

TABLE OF RESULTS INDICATING THE RATE OF SPREAD OF TOMATO VIRUS IN TOMATO PLANTS

Series of Colonies	Condition of all shoots twenty-four days after inoculation date; 0 - healthy; X - mosaic					
	Inoculated shoot	Daughter plants separated from colony at specified intervals after inoculation date				
		3 days	10 days	15 days	19 days	24 days
A	X	0	X	X	X	
B	0	0	0	0	0	
C	X	0	0	X	X	
D	X	0	0	0	X	X
E	X	0	X	X	X	X
F	X	0	X	X	X	XX
G	0	0	0	0	0	0
H	X	0	0	X	X	

After inoculation a single secondary plant was removed from each colony at intervals of three, ten, fifteen, nineteen and twenty-four days where the number of daughter plants was sufficient for such a series. These isolated plants were kept under observation to see if mosaic developed.

Twenty-four days after inoculation a record of the various series indicated that in two colonies (B and G) the inoculation had failed. There was no sign of mosaic in the shoot originally inoculated or any of the daughter plants in either colony. In the remaining six all plants removed after nineteen days had marked mosaic symptoms on the young growth; in five of the six the disease had appeared in plants removed after fifteen days; and in three plants taken away after ten days the disease was also evident. None of the plants removed after three days had developed mosaic twenty-four days after inoculation.

It is evident from the above results that the infective principle was unable to pass from the point of inoculation beyond the place of separation in any case in three days; that in half the cases not more than ten days was required to traverse this distance; that in five out of six cases the virus had passed into the daughter plants in less than fifteen days; and that in only one case was a period of fifteen days insufficient. In this case the two plants removed after nineteen days were both affected by mosaic on the twenty-fourth day, so that if one allows for a suitable incubation period it is evident that the point of separation must have been passed near the fifteen-day period.

The distances to be traversed by the virus in these colonies varied from eight to eighteen inches. We may see from the above records that these distances were traveled by the virus in periods which might be something less than ten days or slightly more than fifteen days. We have no right to assume that a uniform advance was made during this period, but for purposes of expressing the rate of progress of the virus in concrete fashion it may be permissible to adopt the average rate in common usage for such purposes. On this basis the transfer of mosaic virus appears to take place through the shoots of the tomato plant at a rate somewhere in the neighborhood of one to two inches per day or one to two millimeters per hour.

W. A. McCUBBIN,
F. F. SMITH

PENNSYLVANIA BUREAU
OF PLANT INDUSTRY,
HARRISBURG

FEEDING PLANTS MANGANESE THROUGH THE STOMATA[1]

DOES manganese benefit plants mainly by increasing the oxidative power of the soil, as has been claimed by Skinner and Reid[2] or is its chief value as a promoter of enzyme activity within the plant, as stated by Bertrand?[3] McHargue[4] has demonstrated

[1] Contribution 354 of the R. I. Agricultural Experiment Station, Kingston, R. I.

[2] Skinner, J. J., and Reid, F. R., "The Action of Manganese under Acid and Neutral Soil Conditions." *U. S. D. A. Bull.* 441. 1916.

[3] Bertrand, Gabriel, "Sur l'intervention du Manganese dans les Oxidations provoqués par la laccase." *Compt. Rend. Acad. Sci.* (Paris) I: 124: 1032–1035.

[4] McHargue, J. S., "The Rôle of Manganese in Plants." *Jour. Am. Chem. Soc.* 44: 1592–1594. 1922.

that it is essential for the normal development of many kinds of plants. Gilbert, McLean and Hardin[5] have found it to be a cure for lime-induced chlorosis of spinach and oats. Similar beneficial results have been obtained with tomatoes on lime soils in Florida, according to Schreiner and Dawson.[6] Unpublished data also show similar benefits to beets, lettuce, onions, corn and millet on neutralized soils.

Since the need for manganese on neutralized soils appears to be so general with many kinds of plants it is worth while to know whether its action is mainly on the soil or within the plant itself. This question was answered in the experiment here described by supplying some chlorotic plants with manganese through the soil, and introducing it into the tissues of others directly through the stomata of the leaves. This last was accomplished by an adaptation of the porometer, used by Darwin and Pertz[7] for studying stomata openings, and modified by McLean and Lee[8] for inoculating citrus leaves with canker organisms. The apparatus consisted of a small glass medicine-dropper tube with a rubber lip on the large end so that it could be pressed against a delicate leaf without causing injury. The small end of the tube was connected with a rubber atomizer bulb so that air could be forced into it under pressure. Then the tube was filled with a dilute manganese solution, its open large end pressed downward on a leaf, and the solution pumped into the intercellular spaces through the stomata. By using potted plants and tilting the pots on their sides, it was possible to inject the intercellular spaces of the leaves nearly full of the solution, then wash off with distilled water any surplus that might adhere to the leaves, without getting any of the solution into the soil.

In this way the effects were noted of supplying manganese to chlorotic spinach plants into the leaves through the stomata and also of supplying it to the soil. Equally prompt benefits were observed by both methods of treatment.

For this test six Wagner pots, each filled with about 10 kilograms of neutralized soil, were planted to spinach on April 20. On May 17, the plants had two to three leaves each and were very chlorotic. The pots were then arranged in pairs, each pair containing comparable plants. Then the plants in one of each pair of pots were treated with manganese sulphate solution. The treatments were as follows:

Pot No.	79	150 cc. solution of 50 p.p.m. of manganese poured on the soil.
" "	166	Control, no manganese.
" "	15	Injected 50 p.p.m. manganese solution into leaves of alternating plants; eight being injected, nine left untreated.
" "	36	Control, no manganese.
" "	78	Ten plants injected with 50 p.p.m. manganese solution, eight plants injected with 5 p.p.m. manganese solution.
" "	62	Control, no manganese.

On May 24, one week after treatment, the plants injected with 50 p.p.m. manganese solution were greener than the control plants and showed the greatest improvement. The plants injected with 5 p.p.m. manganese solution and those receiving manganese through the soil were also greener than the control plants, but not equal to those receiving 50 p.p.m. On May 31, it was noted that the plants which received 50 p.p.m. of manganese were greener, but smaller, than those receiving only 5 p.p.m.

On June 7, the plants were harvested and weighed green, with the following results:

Pot No.	Treatment	Number of plants	Green weight total	Green weight per plant	Per cent increase over control
			gm.	gm.	per cent
79	50 p.p.m. manganese on soil	13	85	6.5	51
166	Control	13	56	4.3	
15	Injected 50 p.p.m. manganese solution	8	57	7.1	29
15	No treatment	9	49	5.4	
36	Control	11	60	5.5	
78	Injected 50 p.p.m. manganese solution	10	60	6.0	20
78	Injected 5 p.p.m. manganese solution	8	57	7.1	42
62	Control	19	95	5.0	

The average weight of the control plants was 5[illegible]

[5] Gilbert, Basil E., McLean, Forman T., and Hardin, Leo J., "The Relation of Manganese and Iron to Lime-induced Chlorosis." *Soil Science* 22: 437–446. 1926.

[6] Schreiner, Oswald, and Dawson, Paul R., "Manganese Deficiency in Soils and Fertilizers." *Jour. Ind. and Eng. Chem.* 19: 400–404. 1927.

[7] Darwin, F., and Pertz, D. F. M., "A New Method of Estimating the Aperture of Stomata." *Proc. Royal Soc.* London, Ser. B, No. B569: 136–154. 1911. Cited by Samuel F. Trelease and B. E. Livingston, "The Daily March of Transpiring Power as indicated by the Porometer and by Standardized Hygroscopic Paper." *Jour. Ecol.*, No. 14: 1. 1916. Abstract in SCIENCE, New Ser., 43: 363. 1916.

[8] McLean, Forman T., and Lee, H. Atherton, "Pressures required to Cause Stomatal Infection with the Citrus Canker Organisms." *Philippine Jour. Sci.* 20: 309–320. 1922.

grams, and of the treated plants 6.6 grams, the average increase due to the manganese being 30 per cent. Manganese was apparently about equally effective whether injected into the tissues of the leaves or applied to the soil. Also, the control plants in Pot 15, which alternated with the injected plants in the same pot, were benefited neither in weight nor appearance by the treatment of the adjoining plants. So it is quite safe to conclude that this lime-induced chlorosis was cured by the action of the manganese within the body of the plant. The changes brought about in the soils by additions of manganese may be beneficial, but such changes were clearly not necessary for the recovery of the spinach in these experiments, while the injection of manganese solutions into the plants was clearly beneficial.

This method of injection of solutions into the leaf tissues through the stomata may be advantageously employed in the study of other diseases of plants suspected to be due to deficiency of soluble substances.

FORMAN T. McLEAN

RHODE ISLAND STATE COLLEGE

SOUTHWESTERN ARCHEOLOGICAL CONFERENCE

On August 29–31, 1927, there was held at the excavation camp of Phillips Academy, Andover, at Pecos, New Mexico, an informal gathering of workers in Southwestern archeology and related fields. There were present: C. Amsden, Southwest Museum; Monroe Amsden, Southwest Museum; Lansing Bloom, Museum of New Mexico; K. M. Chapman, Museum of New Mexico; H. S. Colton, University of Pennsylvania; C. B. Cosgrove, Peabody Museum of Harvard; Harriet Cosgrove; Byron Cummings, University of Arizona; A. E. Douglass, University of Arizona; Clara Lee Fraps, University of Arizona; Charlotte Gower, University of Chicago; O. S. Halseth, Arizona Museum; M. R. Harrington, Museum of the American Indian; E. L. Haury, University of Arizona; E. L. Hewett, Museum of New Mexico; Walter Hough, U. S. National Museum; N. M. Judd, U. S. National Museum, National Geographical Society; A. V. Kidder, Carnegie Institution and Phillips Academy; Madeleine A. Kidder; A. L. Kroeber, University of California; T. F. McIlwraith, University of Toronto; H. L. Mera, Indian Arts Fund; Paul Martin, Colorado State Museum; S. G. Morley, Carnegie Institution of Washington; Frances R. Morley; E. H. Morris, Carnegie Institution of Washington; Ann A. Morris; J. L. Nusbaum, National Park Service; Frank Pinkley, National Park Service; E. B. Renaud, University of Denver; Oliver Ricketson, Carnegie Institution of Washington; Edith B. Ricketson; F. H. H. Roberts, Jr., Bureau of American Ethnology; Linda Roberts; J. A. B. Scherer, Southwest Museum; H. Shapiro, American Museum of Natural History; Leslie Spier, University of Oklahoma; Erna Gunther Spier; H. J. Spinden, Peabody Museum of Harvard; J. B. Thoburn, Oklahoma Historical Society; T. T. Waterman, University of Arizona; R. Wauchope, University of South Carolina.

The purposes of the meeting were: to bring about contacts between workers in the Southwestern field; to discuss fundamental problems of Southwestern history, and to formulate plans for coordinated attack upon them; to pool knowledge of facts and techniques, and to lay foundations for a unified system of nomenclature.

The morning of Monday, August 29, was spent in inspecting the academy's excavations in the pre-Pecos site at Bandelier Bend, and in visiting the main Pecos ruin. Monday afternoon and the mornings and afternoons of Tuesday and Wednesday were devoted to the business of the meeting, less formal campfire gatherings being held each evening. On Thursday, September 1, several members of the group visited the excavations of the School of American Research at Puyé by invitation of Director E. L. Hewett.

In the preliminary discussions, special attention was paid to the classification of Southwestern culture-periods. There was entire unanimity in regard to the general nature of Southwestern culture-growth, *i.e.*, that its basic element, maize agriculture, was derived from the South; that from time to time certain other highly important elements such as cotton-growing, loam-weaving, and probably pottery-making, were also introduced from the same source; but that little more than the germ-ideas of these elements penetrated to the Southwest; and that the development of its culture was essentially autochthonous.

There was practical unanimity as to the course of development, *i.e.*, that agriculture was taken up by a previously resident, long-headed, nomadic or semi-nomadic people, who did not practice skull-deformation, and who already made excellent coiled basketry, twined-woven bags, sandals, and used the atlatl; but whose dwellings were of perishable nature. The newly acquired art of agriculture led to a more settled life and to the development of more permanent houses. For some time, however, pottery-making was unknown. At a later date pottery was introduced, or possibly independently invented, houses of the pit type were perfected, and became grouped into villages, and the bow-and-arrow began to supplant the atlatl. The long-headed race, however, still persisted.

At a still later period there appeared certain important changes: skull-deformation was initiated (the majority of those present at the conference believe that a new, broad-headed strain supplanted the ancient long-heads); dwellings emerged from the ground, the rooms became rectangular, and were grouped more closely; structural rings (corrugations) were for the first time left unobliterated on cooking vessels. From then on the development of the culture was rapid. After a period of wide extension, marked by small-village life, there was, perhaps a decrease in amount of territory occupied, and surely a concentration of population in certain areas, together with great architectural and ceramic achievement and strong regional specialization. Subsequently large areas were abandoned, there appears to have been a considerable shrinkage of population, and there was a definite cultural degeneration. This period was brought to a close by the settlement of the Southwest by the Spanish about 1600.

The meeting attempted, as a basis for more precise definition of culture-stages, to arrive at agreement as to diagnostic culture-traits. A sub-committee prepared a chronological tabulation of elements, which was used during the subsequent discussions. Architecture was considered to be of much value as an index of growth; as were village-types, sandals, pictographs, etc. Much further information, both as to nature and distribution, was decided to be needed, however, before these categories can be used with full confidence. Pottery, it was agreed, is at the present time the most abundant, convenient and reliable criterion, and the cooking wares the simplest type for preliminary chronological determinations. Discussion brought out the following outline of development in this class of ceramics: first, plain wares; later, neck corrugations produced by leaving unobliterated the upper structural rings; still later, spiral corrugations ornamented by indentations and covering the entire vessel; again later, a degeneration of the corrugated technique, and, finally, disappearance of corrugations and return to plain-surface pots.

During all the discussions leading to development of the above outlines, there kept arising questions of period nomenclature. Entire unanimity was not achieved, but the following terms for chronologically sequent periods proved acceptable to the majority:

Basket Maker I, or Early Basket Maker—a postulated (and perhaps recently discovered) stage, pre-agricultural, yet adumbrating later developments.

Basket Maker II, or Basket Maker—the agricultural, atlatl-using, non-pottery-making stage, as described in many publications.

Late Basket Maker, Basket Maker III, or Post-Basket Maker—the pit- or slab-house-building, pottery-making stage (the three Basket Maker stages were characterized by a long-headed population, which did not practice skull-deformation).

Pueblo I, or Proto-Pueblo—the first stage during which cranial deformation was practiced, vessel neck corrugation was introduced, and villages composed of rectangular living-rooms of true masonry were developed (it was generally agreed that the term pre-Pueblo, hitherto sometimes applied to this period, should be discontinued).

Pueblo II—the stage marked by widespread geographical extension of life in small villages; corrugation, often of elaborate technique, extended over the whole surface of cooking vessels.

Pueblo III, or Great Period—the stage of large communities, great development of the arts, and growth of intensive local specialization.

Pueblo IV, or Proto-Historic—the stage characterized by contraction of area occupied; by the gradual disappearance of corrugated wares; and, in general, by decline from the preceding cultural peak.

Pueblo V, or Historic—the period from 1600 A. D. to the present.

As a by-product of the effort to define the various Pueblo periods, the following definition of a pueblo as an architectural type was arrived at: A pueblo is an agglomeration of essentially rectangular living rooms of adobe or masonry construction, generally flat-roofed and built above ground.

There was much discussion of the term "kiva" and of such parts of kivas as the ventilating passage, the fire-screen or deflector, etc. It was agreed that ceremonial rooms varied so greatly in form and in interior arrangement, and that the types shaded into each other so imperceptibly that no valid distinction as to essential function could be drawn between, for instance, round and square, or between above-ground and subterranean examples. The following very broad definition was therefore adopted: A kiva is a chamber specially constructed for ceremonial purposes.

It was hoped that the meeting could devote attention to the nomenclature of areas, of pottery types, pottery forms, elements of decoration, etc.; but so many matters of greater immediate interest were brought up that these questions were deferred with the idea that they should be kept in mind by those present and gone into at a possible future gathering. It was, however, thought well to consider the advisability of a binomial ware-nomenclature; the first name to be indicative of the locality of highest development, the second a technically descriptive term; for example, Sikyatki yellow, Mimbres black-on-white, Upper Rio Grande incised, etc.

There was no opportunity for consideration of the difficult and at present very confused question of names for design-elements, but Mr. K. M. Chapman,

of the New Mexico State Museum, Santa Fe, who has given this matter much study, offers to act as clearing-house for suggestions as to the nomenclature of design and to prepare a preliminary report as basis for further discussion.

A survey was made of work now in progress or in contemplation, and areas under investigation were plotted on a map of the Southwest. This brought out the fact that although certain central areas are under intensive study, the peripheral regions, with the exception of Nevada, are being neglected. Information is badly needed as to the extent and nature of remains in southwestern Arizona, Sonora, Chihuahua, and eastern New Mexico. Of the central districts, the Little Colorado in general and the Hopi country in particular deserve attention. Chronologically considered, the field is being fairly well covered, but Basket Maker I and II, and Pueblo I and IV should be more strenuously attacked. It was emphasized, however, that in spite of the need for much more work, it should become a practice to operate intensively rather than extensively, to make each excavation a model of care and thoroughness, and to leave undisturbed large parts of all important sites in order that they may be studied by the better-equipped students that the future is certain to produce. It was brought out that our present methods for the preservation of skeletal material leave much to be desired.

Mr. J. L. Nusbaum, who has recently been appointed archeologist for the Department of the Interior, and been given supervision of the many ruins on the lands administered by that department, led a discussion of the issuance of permits, the handling of expeditions, the treatment of ruins during and after excavation, and the publication of results. Mr. Frank Pinkley, of the National Park Service, who is in charge of Southwestern monuments, offered valuable suggestions as to the relation between field-workers and Park Service personnel. He also advocated the placing of permanent markers on or near all sites excavated, to which surveys of work done should be tied, in order that excavated areas can in the future readily be located.

Advantage was taken of the presence of Dr. Byron Cummings, who is, under recent state legislation, responsible for the issuance of permits for work in Arizona, to discuss the question of archeological investigations in that state. This led to a general consideration of state laws, of the rights and duties of states and of outside institutions, and of unauthorized digging on public and private lands.

Dr. A. E. Douglass reported his researches on the climate of the southwest and gave the results of his study of tree-rings in their relation to the dating of pueblo and cliff-house ruins. He appealed for the help of all field-workers in the gathering of further materials for this all-important investigation.

A. V. KIDDER

CARNEGIE INSTITUTION OF WASHINGTON
AND PHILLIPS ACADEMY

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FINANCIAL GRANTS TO ADVANCE RESEARCH[1]

FROM the income from the permanent endowment of the American Association a number of grants are made each year to further scientific research. On September 30, 1926, the endowment amounted to \$140,876.66 (Treasurer's report of September 30, 1926), a large part of which (\$42,350) was the accumulation of sustaining-membership and life-membership fees. By constitutional provision, these fees are always invested and only the income therefrom may be expended.

As more of the members realize the opportunities provided by life membership, the number of life members increases. The fee is now \$100. By special action of the executive committee any person who has been a member but who has resigned or has allowed his membership to lapse may at the same time be reinstated and become a life member by paying his total arrearage in annual dues plus an amount sufficient to make a total payment of \$100. The sustaining-membership fee is \$1,000. Well-to-do persons who are interested in insuring the continuous advance of science should be sustaining members.

Besides the sustaining-membership and life-membership fees, the permanent endowment includes the general endowment fund and the Jane M. Smith Fund. The former amounts to \$93,526.66, including the W. Hudson Stephens bequest, the Richard T. Colburn bequest and the Friends' Fund, an accumulation of smaller gifts. The Jane M. Smith fund amounts to \$5,000. By provision of the donor's will the income therefrom must be used each year for creating emeritus life memberships. There are now thirty-seven emeritus members and \$2,850 of the life-membership fund has been received from the Jane M. Smith fund. Aside from the last-named fund, which yields interest at 6 per cent., the association has recently received about 4.64 per cent. on the invested funds. For the fiscal year 1925–26 (from October 1, 1925, to September 30, 1926) the incomes from the general endowment and from the sustaining-

[1] See also SCIENCE for October 7, 1927.

membership and life-membership funds amounted to $4,337.71, $278.23, and $1,686.01, respectively, totaling $6,301.95.

The recent policy of the association has been to maintain in the treasury a small fund available for appropriation in emergency and to appropriate the rest of the available funds each year. Appropriations from the treasurer's available funds are now made in four ways. First, there is a small annual appropriation for treasury expenses, recently $20 for safety-deposit drawer. Second, an appropriation of three dollars per year is regularly made to care for the journal subscriptions of living life members and living sustaining members. For 1926 these amounted to $1,227. Third, grants are made directly by the council or its executive committee from time to time, to organizations or institutions. In this class belong the recent grants to the Naples Zoological Station, to the Barro Colorado Laboratory and to the Concilium Bibliographicum. Fourth, small individual grants in aid of research, amounting to about $3,000 a year, are allotted from an appropriation for that purpose, by the Committee on Grants for Research.

Individual grants are generally for not more than $500, in many cases for much smaller amounts. The annual allotment of these grants occurs in December of each year. Applications may be sent to the Washington office at any time, on application blanks that are supplied by the permanent secretary. For consideration at any allotment, applications must be in hand by December 1. Applicants are notified in January, with regard to the action on their applications, and the grants authorized become immediately available.

A summary of all grants made by the association in past years has recently been prepared in the permanent secretary's office. For information and as a matter of record, résumés of this summary are presented below.

Annual Totals of Individual Grants

Year	*Total Amount*	*Year*	*Total Amount*	*Year*	*Total Amount*
1888	$ 300	1902	260	1916	100
1889	200	1903	300	1917	2,350
1890	400	1904	50	1918	2,900
1891	250	1905	360	1919	3,300
1892	150	1906	150	1920	4,000
1893	200	1908	400	1921	5,000
1895	325	1909	100	1922	3,750
1896	200	1910	60	1923	3,175
1897	100	1911	225	1924	3,425
1899	50	1912	75	1925	2,900
1900	150	1913	100	1926	2,750
1901	283	1915	150	1927	2,050
				Total	$40,538

Grants to Institutions, etc.

Year	*Amount*
1892	$ 100, Naples Zoological Station.
1895	100, Biological Laboratory, Cold Spri Harbor.
	100, Biological Laboratory, Woods Hol
1896	750, Science.
1897	100, Biological Laboratory, Woods Ho
	250, International Bureau of Bibliograph
1898	100, Biological Laboratory, Woods Ho
1904	100, Concilium Bibliographicum.
1906	200, Concilium Bibliographicum.
1907	100, Concilium Bibliographicum.
1908	100, Concilium Bibliographicum.
1909	100, Concilium Bibliographicum.
1910	50, Concilium Bibliographicum.
1911	75, Concilium Bibliographicum.
1912	100, Concilium Bibliographicum.
1913	200, Concilium Bibliographicum.
1915	400, Concilium Bibliographicum.
1916	250, Concilium Bibliographicum.
1919	500, Botanical Abstracts.
	200, Journal of Physical Anthropology.
1920	500, Botanical Abstracts.
1922	250, Botanical Abstracts.
	500, Naples Zoological Table.
1925	200, International Annual Tables.
1926	500, Naples Zoological Table.
	200, International Annual Tables.
	25, Ecological Society of America.
1927	300, Barro Colorado Laboratory.
	500, Naples Zoological Station.
	200, International Annual Tables.
	200, Concilium Bibliographicum.
Total	$7,250

In addition to the above-named grants from treasury funds the following grants have been made from the general funds of the association:

1923	$200, International Annual Tables.
	100, American Institute of Sacred Literature.
1924	200, International Annual Tables.
	60, American Institute of Sacred Literature.
1925	100, National Conference on Outdoor Recreation.
1926	100, National Conference on Outdoor Recreation.
	60, American Institute of Sacred Literature.
1927	55, American Institute of Sacred Literature.

Burton E. Livingston,
Permanent Secretary